THE ENGINEER.

Some Modern Machine Tools.

AUTOMATIC MACHINE TOOLS.

In presenting to our readers a Supplement devoted to modern machine tools, an introduction is scarcely necessary. At the two shows which open to-day at the Agricultural Hall and the Crystal Palace, a large number of the most recent machine tools will be exhibited; and, judging by previous years, we may be sure that a great deal of business will result. It is for this reason that we have elected to publish this Supplement to-day. We feel sure that many engineers who visit the shows, either with the intention of purchasing tools or merely to see them in operation, will be glad to have their mechanism—which in many cases is not a little intricate—explained. We have therefore given drawings and explanatory illustrations of such machines and parts as the makers have permitted. Unfortunately our descriptions of many tools are not nearly so precise as we should like. We must ask our readers to believe that this is in no sense our fault. It is our constant endeavour to persuade toolmakers to put their drawings before us as openly as do engine and bridge builders. That it would be to their profit we have not a moment's doubt. But the competition is keen, and the makers are unwilling to risk giving their rivals any assistance. English makers are at last beginning to agree with us, and two firms have most generously laid complete sets of drawings before us. We refer to Alfred Herbert, Limited, of Coventry, and the Wolseley Sheep Shearing Machine Company, of Birmingham; whilst Joshua Buckton and Co., Limited, have prepared a special sectional drawing for our use. From the drawings of machines made by the two first-named firms, our readers will learn more about the latest automatic tools than they would from hours of close inspection of the tools themselves. We ask them, therefore, to acknowledge with us the courtesy of these firms. Up to the present we have not been so fortunate with American machine toolmakers. They are even more reticent than our average English manufacturers. They are always ready enough to supply us with photographs, which are not a little interesting in themselves, and with short descriptions which may be useful to the purchaser, but are unsatisfactory to the general reader. For this reason our accounts of American tools are not as full as we could wish.

The history of machine tools dates practically from the construction of the slide rest by Maudslay early in the century. The advance from then was fairly rapid for many years, but it is only within the last twenty years that the remarkable strides which have brought the automatic machine to the front have taken place. The automatic machine owes its origin almost entirely to American invention, and we believe we shall be right in saying that the manufacture of a few commercial articles led to its development. Some of the earliest machines were made for the manufacture of sewing machine parts, others for the rapid production of clockmakers' screws, &c., and finally the latest and finest developments have been brought about by the rise of the bicycle interest. The object of the invention of the automatic machine tool is two-fold—it aims at rapid production and at a levelling of the standard of intelligence required to produce a specified piece of work. With regard to the first we shall not be far from the mark in saying that minutes on the latest machines are of the same value as hours on the old-fashioned lathe. But the automatic machine, or rather the full automatic, has its limitations. It cannot deal with work of a greater maximum diameter than 2½in. It is true that larger *full* automatic machines, that is to say, those that make article after article without intervention from the operator, have been made, but the size and weight of the material with which they have to deal, and the necessity of cutting a very large proportion to waste, is inimical to their success. Whether the latest development of all, the introduction of a hopper from which castings or forgings are taken automatically, will remove this difficulty, wholly or in part, it is at present too early to say, but probably the limit of the full automatic machine will never exceed 6in. diameter. One of the latest hopper machines, the first, we understand, to come from America, is exhibited at the Stanley Show by Buck and Hickman, and will be found illustrated and described elsewhere. We are glad to learn that one or two English firms are now engaged on the design of machines of somewhat similar design.

But at the point where the full automatic machine is stopped by inherent and economical difficulties, the semi-automatic and the turret lathe come in. The term semi-automatic is far more vague than full automatic, but broadly speaking, it means a lathe in which, although the attention of the operator is not necessarily required the whole time, it is necessary when a new operation has to be begun. A splendid example of this class of tool is illustrated and described to-day. It is made by Alfred Herbert, Limited, and is superior to any American tool approaching it in size which we have had the pleasure of inspecting.

It has been frequently said that English machine tools are inferior to those of America. There is no doubt much truth in that observation within certain limits. There can be no question, for example, that British tool makers and British tool users have been very conservative. Designs which fathers found good, sons have commended. The workman, too, has been averse from progress. But both users and makers are waking up. Several English firms have been working away quietly at the construction of modern tools, and they are beginning to reap their harvest. There are, moreover, signs that the British maker, having learnt his lesson from his American cousin, will some day beat or teach his master. American makers are already giving up the inverted V bed, which was at one time so popular with them, and are following the English example in providing a large flat rubbing surface. Collaterally with that improvement they are providing means for preventing the tilting or rocking of the slides and turrets, which were wanting in older machines. Probably they will also ultimately give up the soft spindle running in soft brass or Babbitt metal, and adopt the English method, and use a hard steel spindle in the hardest bronze, both lapped or ground dead true. These features are essentially English characteristics; they make for stiffness and long life. At present it may be said with honesty and fairness, that where English makers have followed American general designs or principles they have made better machines than any that come into this country. The time is coming when they will do their own designing, and do it well. Several firms are already at work on purely British machines. At least one such machine is illustrated in this supplement, and we have heard within the last few days that an entirely novel English machine with many remarkable and valuable features will before long be put on the market by a well-known and respected firm.

In the past, mechanical engineering success depended very largely on the skill and intelligence of the artisan. In the future those qualifications will be needed in a far less degree. The most highly skilled persons in a workshop will be those who make and repair the tools. For most other purposes the labourer will be as efficient in a general way as the trained mechanic.

Amongst other classes of machine tools, the advance of electricity is opening up new and remarkable developments. It has been the custom for many years to use a certain number of portable tools in nearly all works; but the difficulty of supplying them with power has always kept their size within comparatively narrow bounds. Now, however, with the aid of electricity very large portable machines have become practicable; and in the future we may expect to find it the rule rather than the exception to take the tool to heavy pieces of work, instead of bringing the work to the tool. We illustrate to-day two very interesting tools of this description; one of German origin and the other made by one of our best-known English makers, Buckton and Co., of Leeds.

Before commencing a general review of the tools at the shows we have thought that our readers would find it acceptable if a description of the wire feed, which is used on all the smaller machines, were given. We therefore reprint the cut, Fig. 1, and description of the Hartford wire feed, which appeared some months ago in THE ENGINEER, and which is practically representative of all.

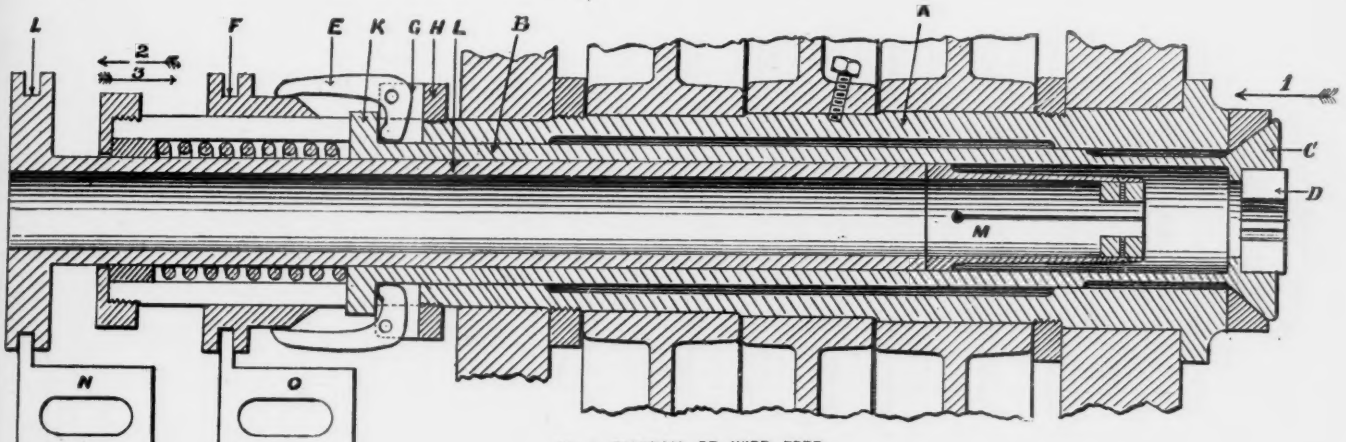


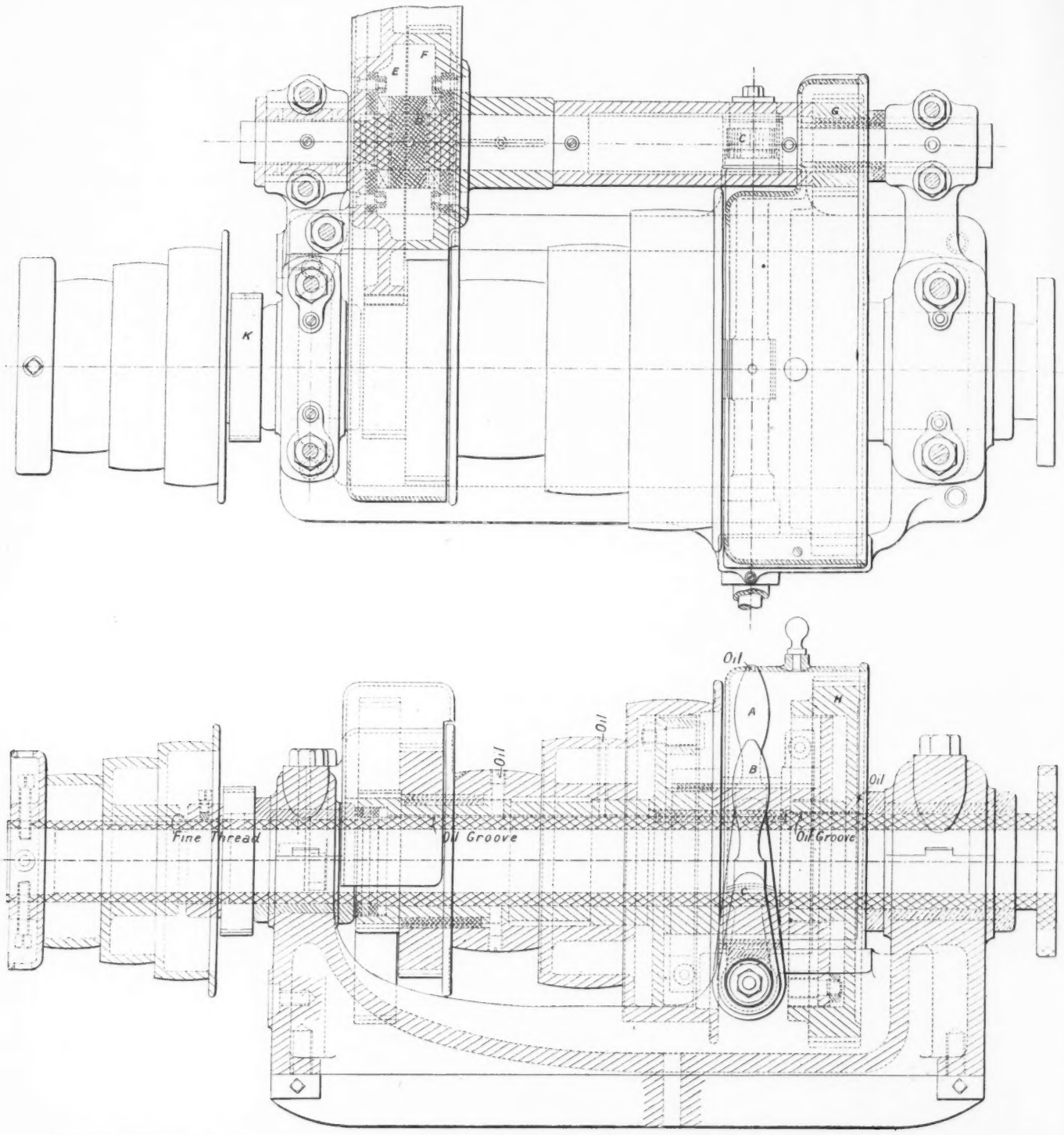
Fig. 1—DIAGRAM OF WIRE FEED.

A is the hollow poppet spindle with bosses of three pulleys shown in position. Within it is a second tube B, bearing at its end the steel chuck C. This chuck has a coned part at its forward end which fits into a similar female cone on the main spindle. The chuck has two or more longitudinal splits, and if left free springs open; when pressed into the cone the jaws close, gripping the stock.

At the rear end of the tube B are two lugs K. Opposite the lugs are two levers E pivoted in the collar G, which is attached to the spindle A, and is adjustable by the nut or collar H. The longer ends of these levers rest on the coned collar F. It is evident that if this cone is pushed forwards so as to open the levers, the tube B will be drawn backwards by the shorter arms of the levers, and in coming backwards the chuck C will close on the work and hold it fast. F is moved forward to accomplish this by a roller or pin on the lower part of the slider O being pressed by one of the steel strips *b* on the drum. When another strip *a* is acting, F is pushed backwards, and B is moved forwards by the spiral spring shown acting on its base; the chuck is then free to open and the stock to move. It is then that a third tube M comes into action. This tube also carries a split steel chuck at its forward end. This chuck is, however, pinched inwards so as to always grip the stock. At the back end the tube terminates in the grooved collar L. A tail piece on a second slipper N works in this groove, and the slipper is moved backwards and forwards by a second lot of cams *c d*, the latter of which should be further to the right than shown, on the stock feed drum. The tube M carries the stock forward into position, but slides back on it after it has been gripped by the chuck C.

No. 6 HEXAGON TURRET LATHE—HEADSTOCK

ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS



HEXAGON TURRET LATHE.

One of the finest exhibits of machine tools which has ever been seen in London is that of Alfred Herbert, Limited, at the Crystal Palace. In the arrangement of their stand a distinct idea has been followed. The machines are not put down anyhow, as is usually the case, but are arranged in the way that automatic machines are most economically placed. All machines which work on a stock bar or shaft are under the disadvantage that room must be allowed for this bar to protrude from the back of the headstock. There are three ways in which this can be done :—(1) The machines may be placed far enough apart to allow of the stock being got in ; (2) they may be stepped so that the stock from one lathe passes behind the next ; (3) they may be slanted to a sufficient angle to allow of the stock of one lathe passing the back of the next. The first method is as a rule quite out of the question—few firms can afford to sacrifice the amount of space involved. In some cases it can be, and has to be, used, but the machines are generally arranged one behind the other with the stocks all projecting at one end, passing through a hole in a wall if necessary. To this arrangement there are two objections. In the first place, the countershafting is involved and troublesome ; and in the second, the workman—who as a rule tends two or more machines—cannot get from the front of one to the front of the other rapidly. In the second method the countershafting is arranged without difficulty, and there is no trouble in getting from one machine to another, but it is not economical of space, as the machines take a diagonal line across the shop. Experience has shown that the slanting arrangement is the best, and it is now almost universally adopted. The stand before us is planned in this way with a row of tools on each side, and a clear aisle between them. The total area covered is 80ft. by 20ft. Two-thirds of this is devoted to machinery in motion. There are ten lathes and automatic machines and two grinders at work. Over the centre aisle runs the main shaft transmitting power to countershafts on each side, under which the machines are placed. The exhibit includes automatic machines and capstan lathes of various sizes, but we propose to deal with only one, and that very fully, instead of making a hurried survey of the whole. But we illustrate a smaller lathe on page iv. We feel that this will be the more satisfactory to our readers, and as Alfred Herbert, Limited, are the largest and most experienced makers of modern automatic machine tools in this country, we feel sure that the drawings of their largest hexagon lathe, which they have with great courtesy put at our disposal, will be examined with interest and profit. We also reproduce several photographs of the speed and feed gears, which will perhaps be more readily understood than the drawings A word of explanation is necessary with regard to the hatching or shading on the latter. All the drawings are in elevation, but the section lines are shown as well. Once this is understood, drawings made on this plan are, if anything, more easy to read than those from which the hatching is omitted.

This lathe is, as we have said, the largest of its kind made by Alfred Herbert, Ld. It is known as No. 6 ; it is essentially an engineer's lathe. It is designed for dealing with a large variety of chuck work, such, for instance, as turning and boring stop valves, pulleys, &c. But it can also be used for bar work, and has a spindle through which a $2\frac{3}{8}$ hole is bored. It has an hexagonal turret carrying six tools, and a saddle with a square turret to take four tools. Thus, when required, no less than ten different tools can be rapidly brought into operation. It will, moreover, screw-cut either small or large diameters, and either right or left hand. It has double back gear controlled by clutches giving ratios of 4 to 1 and 15·7 to 1, and is usually provided with a two-speed countershaft, so that six graduated speeds can be obtained on each step of the cone, or 18 speeds in all, without stopping the lathe. The cone pulley has three steps, 12in., 15in., and 18in. in diameter, and takes a 4in. belt. The hexagon turret measures $18\frac{1}{2}$in. across the faces. In each face is a hole $3\frac{1}{4}$in. diameter for receiving shank tools, boring bars, &c., or for allowing long work to pass right through the turret. Special holders for taking several tools can be bolted to the faces. The turret has nine changes of feed in either direction, three of which can be obtained without touching the feed belt, and it has six independent stops.

The saddle carries four tools, has the same number of feed speeds as the turret, and has sliding and surfacing motions, to each of which four separate adjustable stops are fitted. In addition to this the saddle is furnished with independent screw-cutting motion, obtained by using a leader and nut, in conjunction with a quick withdrawing motion, combined in such a way that one movement of a handle withdraws the tool from the work and the nut from the leader, and a reverse movement of the handle puts the nut into gear with the leader, and returns the tool to the cutting position. Right and left-hand threads are cut by simply moving a handle. Each leader will cut four pitches without the use of loose change wheels. The sliding, surfacing, and screw-cutting motions are inter-

No. 6 HEXAGON TURRET LATHE—TURRET SLIDE

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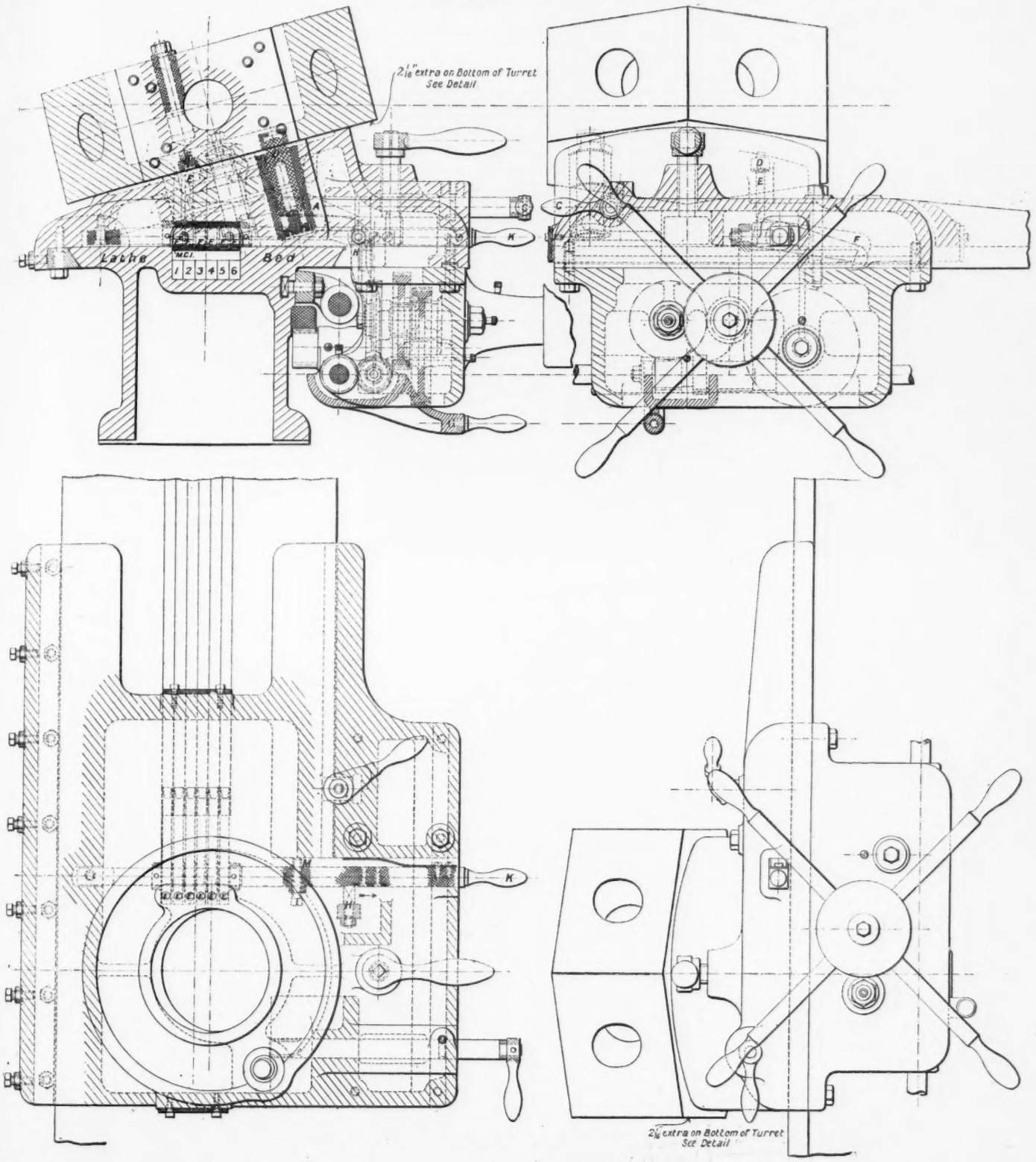

locked, rendering it impossible for any two motions to this saddle to be engaged at the same time. We pass on now to a consideration of the detailed drawings.

The headstock is shown in plan and elevation on page ii. There is a main three-step cone and a second cone for the feed; a double back gear and a double friction gear; the spindle is hollow, and will take 2¼in. stock. It is carried in two bearings of hard bronze, which are fitted to it with very great care. They are held by caps secured by two bolts, and a large tenon or feather on each side. The use of loose caps, which is the ordinary American practice, is frequently condemned in this country as inferior to the solid heads which most English makers adopt. Bearing this in mind, we have made a point of inquiring both into the manner in which these caps are fitted and as to whether they give trouble. We find that the life of the brasses is, as a rule, many years, and that if they are properly adjusted to begin with, and properly used, they give no trouble; indeed, when the care which is taken to make such caps fit properly, and to take any side strain off the bolts, is considered, it is hard to see why they should not be as satisfactory as solid heads. That it is a far simpler matter to design a good headstock if this feature is once allowed to enter it, will be admitted on all hands. The cone spindles which were and still are so largely used by British makers must, we believe, ultimately give place to the parallel bearing. The cone was admirable for its day, but the advent of harder wearing brasses and the possibility of superior machinery and fitting, and the greater knowledge of the work imposed upon it, has removed the necessity for a ready means of adjusting the spindle. Spindles made on this principle have run for years without interference of any sort. Another thing which is rapidly disappearing from all lathes of small and medium size, and even fairly large machines, is the old form of back gear. It has given place to a friction gear which can be applied instantly. The reason for the discredit into which the simpler and cheaper form has fallen is not far to seek. In the ordinary lathe, which carries but one tool in one position, the time taken to change it for a new operation on any piece of work chucked in the lathe is so considerable that the comparatively short time occupied in changing from single to double gear to suit the new work is inconsiderable. But when several tools are mounted in a turret which can either be swung rapidly round by hand, or even swings itself automatically, the time taken to throw in the back gear would be comparatively long on the old system. Thus it has come about that not only has a single friction back gear been devised, but also a double friction back gear, either of which can be thrown in instantly by the movement of a lever. We have thus in this lathe, single gear, single back gear, and double back gear. Moreover, the countershaft has two speeds, and with the three steps on the cone no less than 18 different speeds can be got, ranging from 4·5 turns per minute to 221. Let us now explain how this is done. There are two levers, A and B, page ii., which stand out in front of the head. They are shown in the elevation, but broken off in the plan. A is keyed to a hollow shaft which passes across the headstock; through it a shaft to which B is keyed passes, projecting at the back and carrying a radius rack C, Figs. 1 and 2. At the back of the headstock is a horizontal shaft on which are cut a few teeth, with which C engages. This shaft is free to slide endways, and carries a double hard steel male clutch D. This simply consists of a rectangular piece of steel let right through the shaft and pinned in place. It can engage, it will be seen, with a female clutch on either side of it, or can remain neutral between the two. It should be observed that the female clutches are also of hardened steel. They are bolted to two gear wheels, one of which is much greater in diameter than the other. The smaller of these wheels engages with a wheel of the same size, which forms part of the step cone, whilst the larger gears with a far smaller wheel cut on a sleeve which passes through the cones, but is keyed to them. According, then, as the clutch D gears with either E or F the back shaft is driven at a less or greater speed. To this shaft is keyed also the pinion G, which engages with a large wheel H, free to rotate on the spindle. Now between H and the largest step of the cone is a friction clutch free to slide on the spindle. According as the

HEXAGON TURRET LATHE

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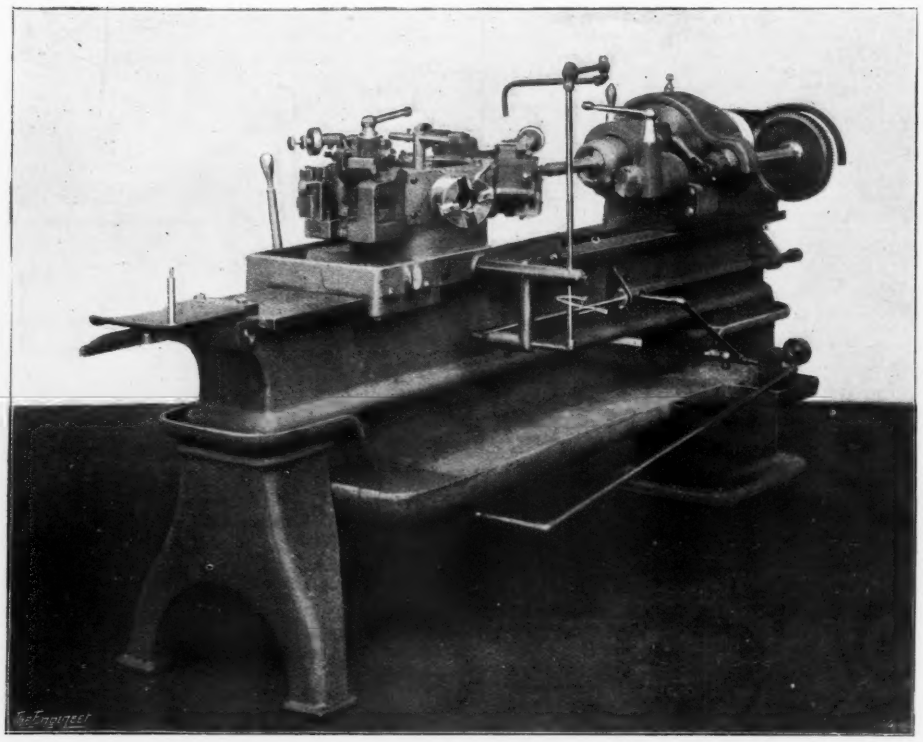


lever A is pressed to the left or right this clutch gears with the cones or the wheel H. If it is pressed to the right then the spindle is driven by the back shaft either at the high speed or the low; if it is pressed to the left the spindle is driven direct; if it is in the central position the shaft is not driven atall, and the lathe can thus be stopped readily. The friction clutches consist of a ring of cast iron attached to a plate by three bolts which pass through holes of a particular form. At a certain point the ring is cut and two little toggle levers are fitted between the extremities; if this toggle is flattened bymoving the lever, the ring is expanded and grips the wheel surrounding it. The shape of the three bolt holes is such that when the toggle is released it closes up equally all round, and is thus quite clear of the wheels. Thus, even when the lever is in the middle position, and the distance between the clutch and the wheels is only slight, the wheels can revolve quite freely and without the slightest rubbing. The whole of

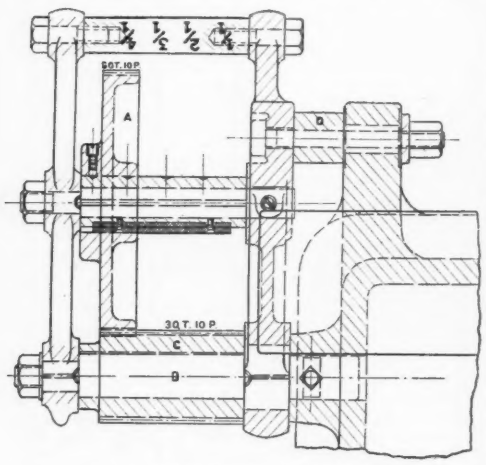


Fig. 2—SCREW-CUTTING CHANGE GEAR

the gear, it will be noticed, is enclosed by suitable covers. The wheel K on the end of the spindle drives the screw-cutting gear. We may here remark that Herbert's gear wheels are probably the most carefully cut in the country. It is no exaggeration to say that even when running fast and light the ear has to be put quite close to the wheels before anything more than the characteristic hum of toothed wheels is heard. There is, we mean, no knock or clatter. The wheels run like the wheels of a clock. This excellence is arrived at by the use of a tooth developing machine, which shows the exact form of the cutter to be used for wheels of any pitch and diameter. It is an excellent point, as there can be no question that if wheels are right to start with wear is but slight, whereas if they are a little out when first fitted the tendency is for them to get more and more irregular, and more and more noisy and wasteful of power as time goes on. Before leaving the headstock, attention should be drawn to the screws passed through lugs for adjusting it centrally with the bed. These are used to adjust it in the shop, and when in position the holes for the holding-down bolts are drilled in position.

To avoid frequent changes of wheels for screw cutting, a device which will be understood from Fig. 2, is introduced in the train. It consists of a wheel A, which can be slid into four different positions. It is carried in a frame, which swings about a fixed shaft B, and can be locked in any position by a bolt D passing through a quadrant. A spindle C is always in gear with this wheel. But A ranges over four wheels of different diameters, with any one of which it may be put in gear. The pinion B through another idle wheel drives the wheel shown in Fig. 4, and so turns the leading screw. Thus ratios of 1, 2, 3, 4, can be got almost instantly.

The mechanism for regulating the rate of feed without shifting the belt is now to be described. In front of the headstock is a box which contains the gear shown in Fig. 4, which is reproduced from a photograph, and is more readily intelligible perhaps than the drawings. It must be remembered that this presents a left-handed view as the box is turned round to face the reader. It will be understood, then, that the step cone corresponds with the step cone on the extremity of the spindle —see page ii.—from which it derives its motion. This step cone is keyed to a shaft, which is hollow for a great part of its length, allowing a second shaft A to enter it. On the outer shaft are slid three wheels as shown, in each of which two keyways facing each other are cut. A key consisting of a rectangular steel pin let through the shaft A projects on each side through a long slot cut in the outer shaft. A can be moved endways by a lever, which has a corresponding exterior lever. According to the position of A, the key which it carries drives any one of the three spur wheels, leaving the other two quite idle. Thus three speeds can be transmitted by these wheels to the shaft above them, on which are keyed three corresponding wheels. These three wheels, through a reversing clutch of a common type, drive the feed shaft at three speeds, and in either direction. In the same box another reversing clutch drives the leading screw, for screw cutting in either direction, but the shaft is driven through the exterior wheel shown, which derives its motion from the pinion K on the headstock spindle through a train. The reversing clutch in each case is actuated by a little lever passing through the box and projecting in front.

We fear a little difficulty will be experienced in understanding the drawings of the saddle. They will, however, amply repay careful study, because they show better than any other part the ingenuity which has been exercised in making these machines accurate and convenient. We begin with the front elevation, and take the traversing or feeding gear first. The saddle can be traversed by hand or by power. Fig. 5, which shows the inside or back of the saddle apron, is left-handed, as in the case of the feed gear. A pinion marked A, keyed to the big hand wheel, drives a second shaft with a pinion B, which engages a fixed rack on the bed of the lathe. When power is required it is taken from the feed shaft C. How this speed shaft is driven has been explained already. A feather way is cut right along it so that it drives the two pinions D and E. Each of these drives a worm and worm wheel F and G—F, through a pinion, transmits motion to B, and gives the power-feed or traverse, whilst G causes the rotation of H, and so by engaging with a wheel on the cross screw gives the cross feed. Now the worms which drive the two wheels F and G are fitted into boxes with their respective pinions D and E, and are fixed to the mechanism only by the shaft C, about which they are free to swing. On each box is cast an extension into which is fixed a handle, Fig. 3. If this handle is lowered the worm will be

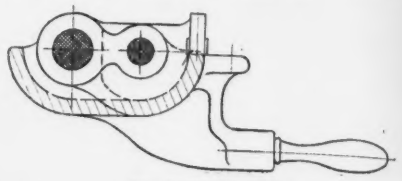


Fig. 3—WORM BOX

lowered with it, out of gear with its corresponding wheel, and thus the feed or cross traverse will be stopped. The worms can when desired be dropped by hand, but automatic arrangements are also provided. That for the feed is seen to the left of the saddle. A horizontal shaft carries on its end a star piece from which four rods project to any desired amount. The star can be rotated into four different positions, and as the saddle moves to the left one of the rods comes against a fixed rod and is stopped. The shaft on which the cross is fixed is free to move a short distance endways, and has at its other end a trigger which supports one of the worm boxes. As the saddle moves forward after the stops have arrested the movement of the shaft the trigger is pushed out of gear, the worm drops, and the saddle stops. The movement necessary to let go the trigger is less than $\frac{1}{10}$in. As the space between the star and the saddle is about $\frac{1}{16}$in. the saddle can still move $\frac{1}{10}$in. forward before it is brought to a dead stop. This final movement is made by hand.

The automatic release for the cross slide is effected in somewhat the same way. The trigger T—see page vi.—which keeps up the worm, is more clearly seen. The trigger is released by being drawn to the right; this is effected by the rod S, which has two inclined faces. As the cross slide nears the end of its stroke the rod is pressed down by the upper inclined face, and the lower incline withdraws the bolt and drops the worm. The gear for depressing the rod is best seen in the plan view. A rod, it will be seen, extends along beside the saddle. To its front end is keyed a finger wheel by which it can be rotated. At its other end four adjustable stops are fixed in any desired position. This rod can move a short distance end ways; at X a deep semicircular groove is turned in it into which

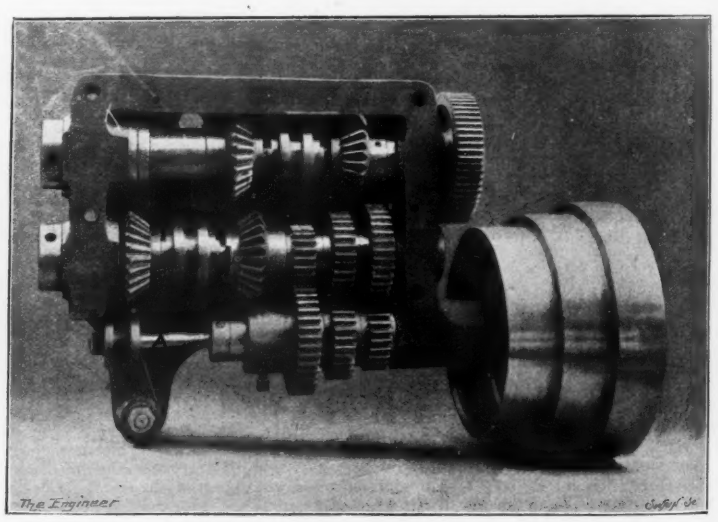


Fig. 4—FEED GEAR BOX

the upper end of S projects. When part of the cross slide touches one of the stops it moves it back, pulls the groove across the end of S, and so depresses it, releasing the worm as already explained. A pin marked "dead stop" allows the final $\frac{1}{10}$in. or so to be made by hand.

We have now to consider the arrangements for screw cutting. In the drawing on page vi. the lead screw is marked M, the driving nut N. N is attached to a slide P, which has a notch in its upper edge. A lever R is keyed to a screwed spindle, on the end of which is a disc, the edge of which enters this notch. This lever is normally down, and in that position N is drawn back clear of the leading screw. But if R is raised the slide P with the nut N is pushed forward against the screw. Another point, and one which will be appreciated by all who cut screws, must be noticed. It will be observed from the plan that the shaft to which the lever R is attached is screwed with a thread of rapid pitch, and passes through a screwed bush. When screw cutting, the disc mentioned above engages also with a notch in a sleeve carrying

the cross feed screw. Now, when the lever is raised to withdraw the block from the leading screw, the shaft comes back too, and in doing so it draws the sleeve and the cross slide back with it far enough to clear the tool from the work. The depth of cut, which is of course adjusted by the top slide, is not altered, and the chalk marking, &c., which has to be resorted to on old-fashioned lathes, is unneeded. It should be explained that removable leaders are used, that the pallet engages with a hard steel plate in a lever K which passes right across the slide. It will be seen that in the position in which it is drawn this arm keeps the worm box raised with the worm gearing with the worm wheel, so that the turret is fed by power. If, however, the lever K is pushed to the right it would release H, which would move in the direction of the arrow, and the worm would fall out of gear. This release is effected is to be observed. The long wedge is set up by a screw at each end, so that the adjustment can be made to a nicety.

We have now brought this description to a conclusion. It occupies considerable space, but we have entered into the subject thus fully for reasons which we believe are good and sufficient. We have heard much lately about the inferiority of English automatic machine tools; we

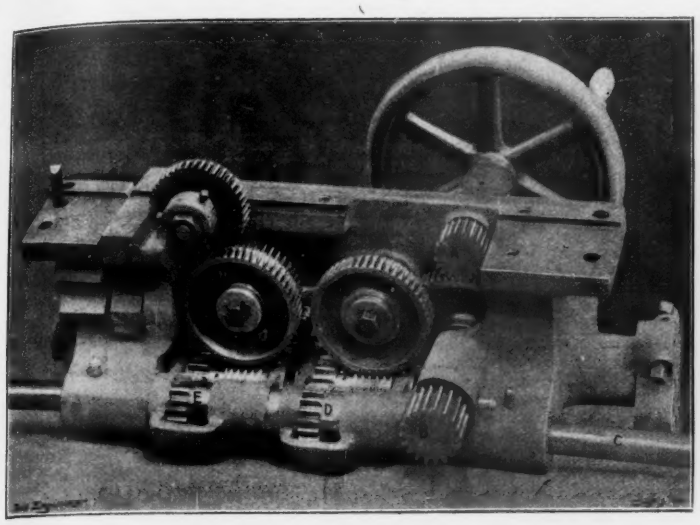


Fig. 5—SADDLE APRON

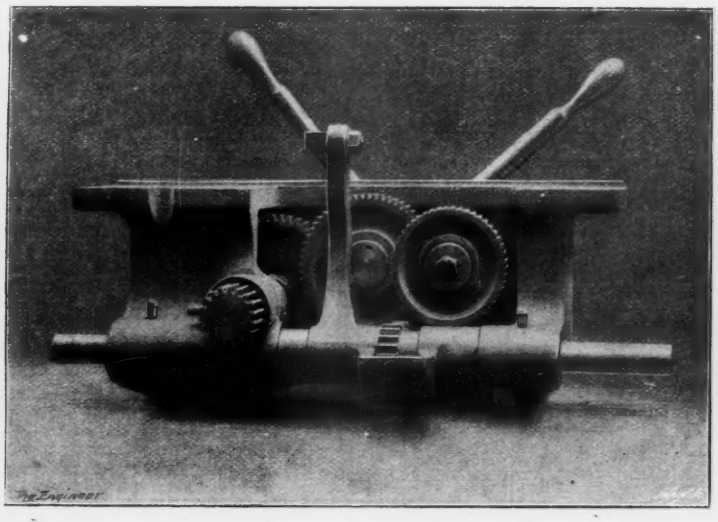


Fig. 6—TURRET SLIDE APRON

each of which can cut four pitches, and no others. When cross cutting is required, the lever R is depressed into its lowest position, and it remains there, the position of the nut slide being the same as when the nut is withdrawn after screw cutting; the screw can then be used for surfacing cuts as in any ordinary lathe. The screw is driven by a pinion, which is wide enough to engage with the gear, transmitting motion to it in either the forward or backward position of the nut slide and sleeve.

We have now to describe the turret and turret slide. They are illustrated on page iii. The turret itself is put on a considerable slant, as in the Gisholt lathe, and for the same reason, viz., that the tools projecting from it may clear the gear in front of the lathe as they swing round. On it is turned a spigot of very large diameter which fits a socket in the slide. A central bolt, clearly seen in the drawing, holds the turret against the face, but is so adjusted as to give as little friction as possible. B is the locating pin sliding an accurate fit through a hard bush in the slide, and fitted into steel-bushed holes in the turret. On the side of the lower end of the locating pin a short rack is cut, into which gear teeth cut in the end of a short shaft A, projecting in front of the saddle, where a small handle C is keyed to it; by turning this handle one way or the other the pin can be raised or lowered, and the turret fastened or released. It is pulled round by hand when it is desired to bring another tool into position, and the locating pin is forced up into the next hole by a spring. The slide can be fed forwards either by hand or by power, a long pair of cross arms are used in the first case, and in the second an arrangement very similar to that for the saddle feed is used. It is illustrated by Fig. 6, and will be understood without further explanation. Attention must, however, be called to the long arm which stands up from the worm box and carries a hard steel pallet at its upper end. This arm can be seen in Fig. 6 standing up to a point just above the upper face of the bed. It is marked H, and it will be noticed in the plan view automatically in a manner now to be described. Between the two sides of the bed there are fitted six long rectangular steel bars marked 1, 2, 3, 4, 5, 6, page iii. Near the end of each bar a notch is cut on its upper face. The bars can be slid backwards and forwards independently of each other, so as to make the notch in each bar take up a desired position. In the drawings all the notches are shown in a line, but this would rarely happen in practice. On the lever K, to which reference has already been made, there are strung six hooks F. If the slide was moving, and any one of these hooks engaged with a notch in one of the bars, the lever K would be pulled back and the worm dropped. A set screw M in the lever K will have been noticed. It is shown set right up against the casting, but in practice would be clear, say, $\frac{1}{4}$in. or so. Now, if $\frac{1}{16}$in. movement was sufficient to release the trigger, the slide could be still moved forward $\frac{1}{16}$ before the set screw coming against the casting stopped it dead.

This final movement, as in the case of the saddle, is made by hand. Now it is evident that were all the hooks free to fall at any time, the carriage would always be stopped by the first notch it came to because that hook would fall in. To obviate this, each hook is prolonged a short way backwards, and on these extensions short rods F rest. The true position of these rods is seen best in the plan. Underneath the turret there are six holes, into each of which a hard steel plug D, with a cupped end, is fitted tight. These holes are so placed that for each position of the turret a hole comes over one of the rods E, and for each position over a different rod. Thus one rod at a time is free to rise sufficiently to allow the corresponding hook to fall when it reaches the notch, whilst all the others are kept down by the lower face of the turret, and the hooks are held up clear of the bars.

Whilst examining these drawings, it is worth noticing the long adjusting strip set up by seven locked screws. In the saddle the excellent adjustment for the cross slide have been told that, both in design and construction, they are inferior to those of German and American make. It is a question on which we have written many times ourselves, and one on which we have encouraged and invited discussion. We have consistently contended that there are points about British designs which render them superior to any other machines in the world. That British engineers have not been as anxious to seize every opportunity for advancement as they should have been is unquestionably true, but there are, at any rate, several firms in this country now at work meeting American competition in its own field. One of our reasons, then, for this exhaustive description is to show what progress one of our most advanced English manufacturers is making. We are prepared to maintain that, in its class, no foreign competitor can show a machine superior to the example we have chosen. To the experienced engineer drawings say far more than words, so that, in putting drawings before them, we give them a far better chance of judging of the qualifications of this tool than if we had merely supplied a general statement of its capacities, its mode of operation, and the speed with which it could execute work. The plan we have been able to follow in this case is that which we believe to be the most desirable, but it is one that we rarely have the opportunity of following. We trust, however, that now, when the ice has been broken by one or two well-known firms, the cold reserve which British machine tool makers have maintained will disappear, and that we shall be able, from time to time, to put similar drawings before our readers.

Before concluding, we should like to call attention to the two tables printed on this page. These tables are selected from several which are issued with all of Alfred Herbert's machines. The use of such tables is characteristic of present machine-shop methods. They show that it is not only in the design of machinery, but in regulations for its use that every opportunity is now taken to effect economies.

No. 6 PATENT HEXAGON TURRET LATHE.

Table of Speeds for Bar Work.

Reducing a bar. From	To	Turns per min. Mild steel.	Wrought iron.	Reducing a bar. From	To	Turns per min. Mild steel.	Wrought iron.	Reducing a bar. From	To	Turns per min. Mild steel.	Wrought iron.
in.	in.			in.	in.			in.	in.		
2¼	2	21	29	2¼	2¼	83	100	1¼	1	55	83
2¼	1¼	25	38	2	1¾	29	45	1⅛	1	67	100
2¼	1¼	29	45	2	1	38	55	1⅛	1¼	100	150
2⅛	1⅛	38	55	2	1¼	45	67	1⅛	1⅛	150	180
2¼	1⅛	45	67	2	1⅛	55	83	1⅛	⅞	45	67
2¼	2	55	83	2	1⅛	67	100	1⅛	⅞	55	83
2¼	2¼	67	100	2	1¼	100	100	1⅛	⅞	67	100
2¼	2⅛	83	100	1⅛	⅞	38	55	1⅛	⅞	83	100
2¼	⅞	25	38	1⅛	⅞	45	67	1⅛	1	100	150
2¼	1	29	45	1⅛	1	55	83	1¼	1¼	150	180
2¼	1¼	38	55	1¼	1¼	67	100	1	⅞	83	100
2¼	1⅛	45	67	1¼	1⅛	83	100	1	⅞	100	150
2¼	1⅛	55	83	1¼	1⅛	100	150	1	⅞	150	180
2¼	2	67	100	1⅛	⅞	38	55	1	⅞	180	270

Table showing Correct Speeds for Screwing Mild Steel or Wrought Iron.

Diameter ...	¼in.	⅜in.	½in.	⅝in.	1in.	1¼in	1½in	1¾in	1⅞in	1⅞in
Turns per minute—										
Whitworth thread ...	67	67	55	45	38	29	29	25	25	21	21
Fine thread..	100	100	83	67	67	55	55	45	45	38	38

No. 6 PATENT HEXAGON TURRET LATHE.

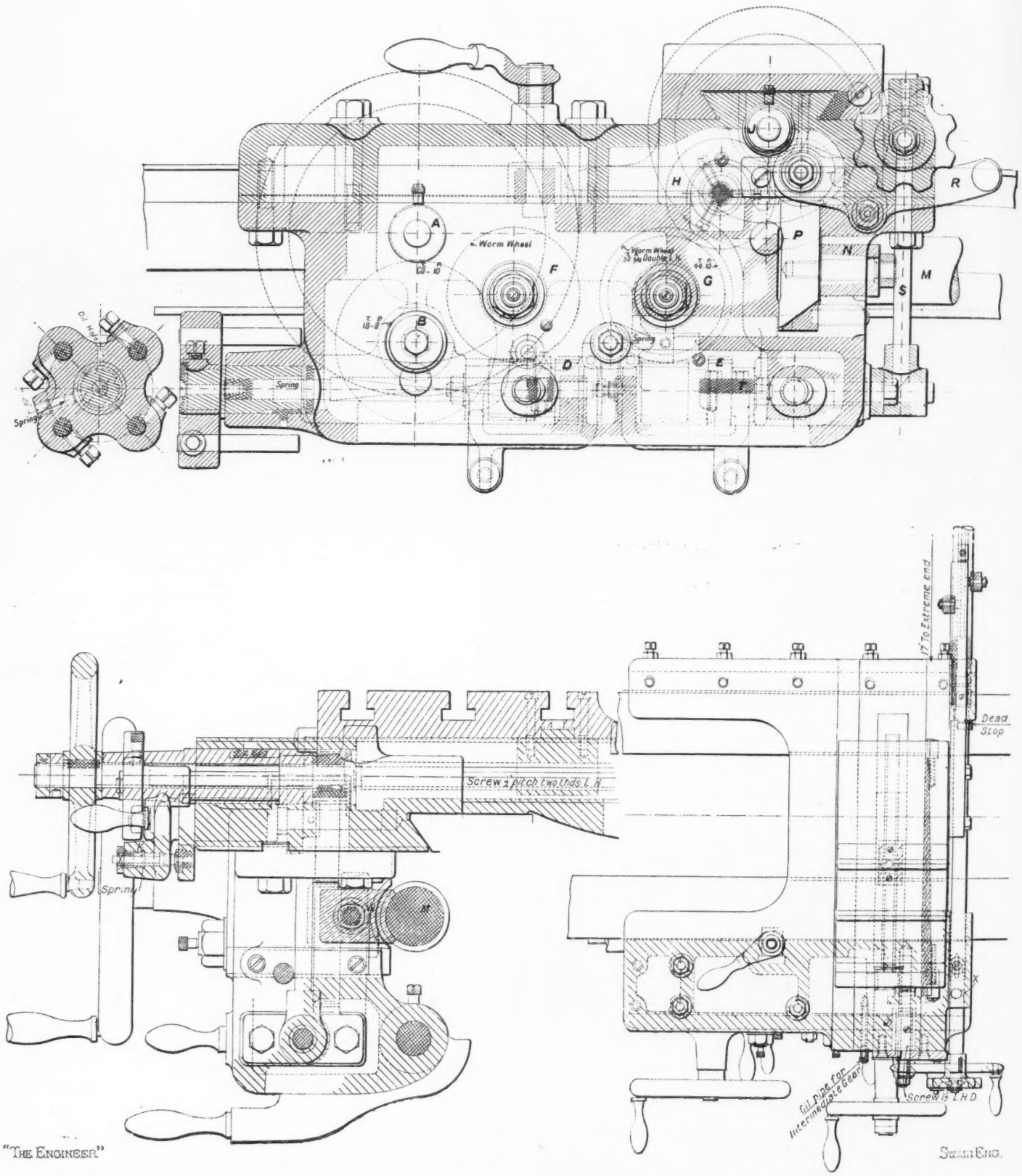
Table of Speeds for Chuck Work.

Turns per min. ...	6	9	11	14	16	19	21	25	29	38	45	55	67	83	100	150	180	270
Diameter	Feet per minute cutting speed.																	
inches.																		
¼	—	—	—	—	—	—	—	—	—	—	—	—	8·7	10·8	13	19·5	23·5	35
⅜	—	—	—	—	—	—	—	—	—	—	8·8	10·8	13	16·3	19·6	29	35·3	53
½	—	—	—	—	—	—	—	—	—	10	11·7	14·4	17·5	21·8	26	39	47	70
⅝	—	—	—	—	—	—	—	—	9·4	12·4	14·7	18	21·9	27·1	32·7	49	58·9	88·3
¾	—	—	—	—	—	—	—	9·8	11·3	15	17·6	21·6	26	32·5	39	58	70	106
⅞	—	—	—	—	—	—	9·6	11·4	13·2	17·4	20·5	25·2	30·6	38	45·8	68·7	82·4	123·6
2	—	—	—	—	—	10	11	13	15·1	20	23·5	28·8	35	43·5	52·3	78·3	94	141
2⅛	—	—	—	—	9·4	11·2	12·3	14·7	17	22·3	26·5	32·4	39·6	48·8	58·9	88	106	159
2¼	—	—	—	9·1	10·4	12·4	13·7	16·3	18·9	24·9	29·5	36	43·8	54·3	65·4	98·1	117·8	—
3	—	—	8·6	11	12·5	15	16·5	19·6	22·7	30	35·3	43·2	52·6	65·1	78	117	141	—
4	—	9·4	11·5	14·6	16·8	20	22	26	30·2	40	47	57·6	70	86·5	104·6	156·6	—	—
5	7·8	11·7	14·3	18·3	20·9	24·9	27·5	32·7	38	49·8	59	72	87·7	108·6	130·9	—	—	—
6	9·42	14·1	17·3	22	25·1	30	33	39·2	45·5	60	70·7	86·4	105·2	130·5	157	—	—	—
7	11	16·5	20·15	25·65	29·32	34·8	38·5	45·8	53·1	69·6	82·4	100·7	122·7	152	—	—	—	—
8	12·5	18·8	23	29·2	33·6	40	44	52	60·4	80	94	115·2	140	—	—	—	—	—
9	14·1	21	25·8	33	37·5	45	49·5	58·8	68·1	90	105·9	129·6	157·8	—	—	—	—	—
10	15·6	23·5	28·7	36·6	41·8	49·8	55	65·4	75·8	99·6	118	144	—	—	—	—	—	—
11	17·27	25·9	31	40·3	46	54·7	60·4	71·9	83·5	109·4	129·5	158	—	—	—	—	—	—
12	18·84	28·2	34·6	44	50·2	60	66	78·4	91	120	141·4	—	—	—	—	—	—	—
13	20·42	30·6	37·4	47·6	54·4	64·6	71·4	85	98·7	129·3	153	—	—	—	—	—	—	—
14	21·9	33	40·3	51·2	58·6	69·6	76·9	91·6	106·2	139·2	—	—	—	—	—	—	—	—
15	23·4	35·3	43·1	54·9	62·7	74·7	82·5	98·1	113·8	149·4	—	—	—	—	—	—	—	—
16	25	37·6	46	58·4	67·2	80	88	104	120·8	160	—	—	—	—	—	—	—	—
17	26·7	40	49	62·3	71·2	84·5	93·4	111	129	169	—	—	—	—	—	—	—	—
18	28·2	42·3	51·6	66	75·3	90	99	117·6	136·5	—	—	—	—	—	—	—	—	—
19	29·8	44·7	54·7	69·6	79·5	94·5	104·4	124·3	144·2	—	—	—	—	—	—	—	—	—
20	31·2	47	57·5	73·3	83·6	99·6	110	130·8	151·6	—	—	—	—	—	—	—	—	—

No. 6 HEXAGON TURRET LATHE—SADDLE

ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS

(*For description see page* iv.)



SOME MACHINE TOOLS AT THE STANLEY SHOW.

THERE is food for reflection in the observation that the only exhibitions of machine tools in London are associated with two bicycle shows. The part which the cycle has played in the development of machine tools has been commented on *ad nauseam*. But although the advance to favour of automatic tools is very largely due to that industry, a comparatively small share of their present popularity is to be ascribed to it. The modern machine tool is becoming less and less the exclusive property of the cycle maker, and more and more that of the general practical engineer. The fact is to be noticed with pleasure. The bicycle industry rose suddenly to a great height. It has now come down to a level which it is probably sufficiently strong to maintain. Its rise was like that of the piston of an indicator on a high-speed engine. It shot up too high at the commencement of the stroke. It fell, and in falling it did much damage; but it has to be written down to its credit that the suddenness of its rise, in overtaxing the capacity of all existing machinery, brought into sudden prominence a type of tool that was till then comparatively little known. As everyone knows, English tool makers were at that time left entirely behind. The market was filled with clever tools of American origin, which have held their place in a way that speaks well for their excellence ever since. We have already expressed our opinion that the time is not very far off when the British manufacturer will again take his right place in an industry which, by its traditions, is peculiarly his own. But that he owes a debt to the cycle trade, and to his cousins on the far side of the Atlantic, he will never forget. Whatever may be the progress which we may make in the design and manufacture of machine tools on the present lines will be due in a very large measure to lessons we have learnt from Americans. Let us be the first to acknowledge that, and let us live in the hope that when next a revolution in machinery is to be made it is we who will teach the world, and so pay back to America the debt we owe her.

The introduction of the new type of machine tools has brought with it entirely new methods of work. There are still many shops in this country where the tool room is unknown, but the complete adoption of that system is merely a matter of time. Many of the tools that are used nowadays it is outside of the ability of the ordinary machinist to keep in order, and far more beyond the capacity of the class of artisan who is now entrusted with the care of machines. This is on the whole an excellent thing, it has lead not only to greater accuracy but to a great saving of time, and that the system must eventually become universal is a foregone

conclusion. We have already dealt with the principal exhibit at the Crystal Palace, and we now turn to the Show at the Agricultural Hall.

The number of exhibitors of machine tools at the Stanley Show is always considerably in excess of the number who exhibit at the National Show. There is an arrangement whereby no maker or merchant can have stands at both places. But, on account of the ease with which goods already in London, or those coming from the country or abroad, can be taken to the Agricultural Hall, the majority of exhibitors prefer sending their goods there to sending them to the Crystal Palace. The exhibition at Islington is, in consequence, always large and interesting, and we propose only dealing with a portion of it to-day, reserving further descriptions till a future issue.

Reference has been made in the introduction to the remarkable tool illustrated in Fig. 1 on this page. This machine is exhibited by Buck and Hickman, of Whitechapel-road. It resembles in a general way the usual automatic machines made by Pratt and Whitney, but it possesses the peculiarity that it deals with separate pieces instead of working from the bar. The annexed sketch, Fig. 2, is a

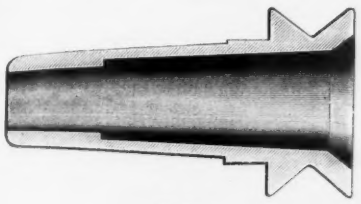


Fig. 2

full-sized section of a piece made by it from a casting. These are made at the rate of about 100 per day, or something over ten an hour, and without any attention being required, except a lad to drop castings into the magazine

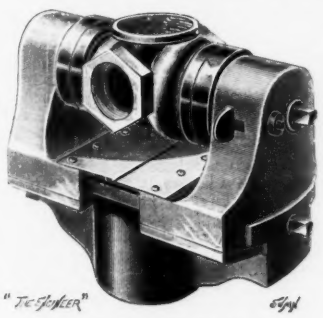
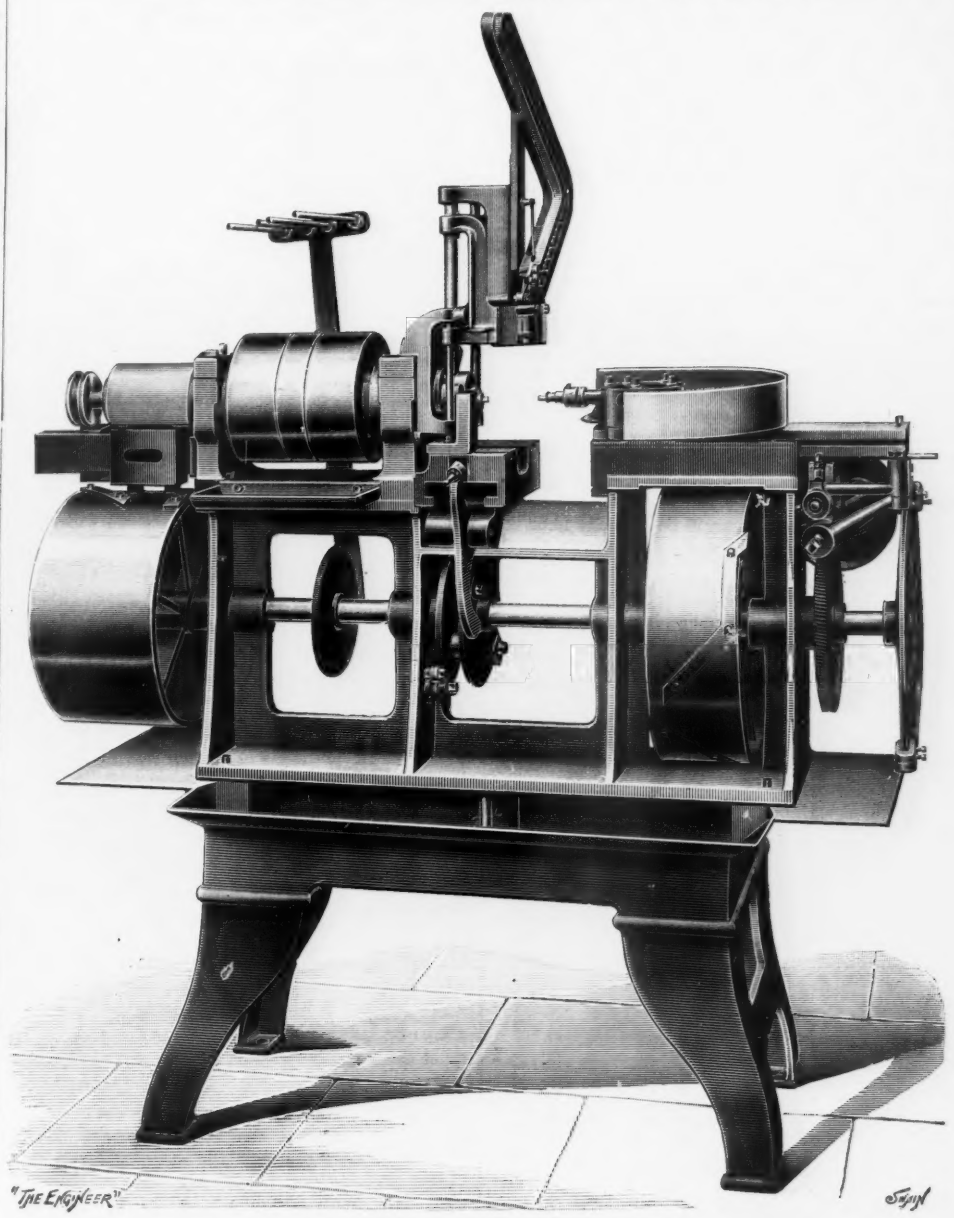


Fig. 3—TUCKER CHUCK

as they are required, and to remove tools when they get dull. Similar machines are also being made for turning bolts from forgings, and on the average about 500 pieces per working day of ten hours are expected from them, one boy looking after from six to eight machines.

Buck and Hickman are showing a number of other

MAGAZINE AUTOMATIC MACHINE



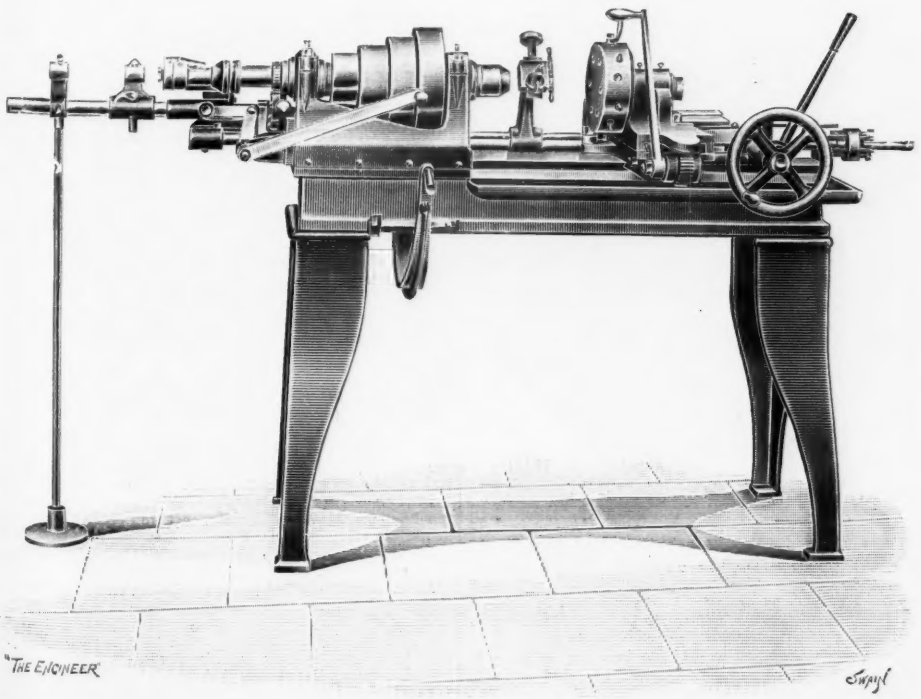


Fig. 4—BURTON VERTICAL TURRET LATHE

automatic machines, but that illustrated is the most novel on their stand, and possibly in the whole show. Part of their exhibit is fitted up to represent a complete tool room, and we shall probably have something more to say about it on a future occasion. A very useful chuck for a variety of purposes is shown by them, and illustrated by Fig. 3 with a piece of work held in it. The two side jaws have large pins or trunnions which enter the work. The jaws are moved up by a right and left-hand screw. It is called the Tucker revolving chuck.

C. W. Burton, Griffiths, and Co., of Ludgate-square, have a large and varied exhibit. In the Burton lathe, Fig. 4, which they show, the turret, instead of revolving round a vertical spindle, as in the majority of turret lathes, rotates round a horizontal spindle parallel with the bed and centre line of the lathe. The turret resembles very closely the chamber of a huge revolver. There are through it six holes, in which various tools can be fitted and held in position by set screws. The tools project from the turret, and only under exceptional circumstances does the work protrude through holes in the turret.

The lathe has a broad, flat bed completely covered on top; the saddle slides on two broad portions on each side of the central part, but at a lower level, so as to allow for ample dovetail. Upon the saddle is a cross slide which carries the horizontal turret. This is quite an exceptional arrangement, as the turret is generally fixed relatively to the lathe centre line. Into the sides of the revolver there is fitted a separate adjustable screw

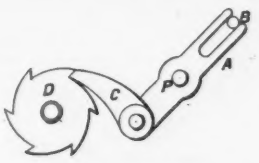


Fig. 5—STOP GEAR

for each tool, which, coming up against a projection on the saddle regulates the amount the cross slide can traverse. This traversing motion is obtained from a long lever which stands up in front of the machine. As long as this lever is above the horizontal it only moves the cross slide. When, however, after one tool has completed its work, the cross slide is pulled right back, the same motion of the lever is continued downwards, and rotates the revolver into the next position by means of a six-tooth wheel on the back of the revolver engaging a pawl fixed in the slide. At the same time a shaft parallel to the bed, which projects backwards from the saddle, is also rotated. On its outer end it carries a drum, through which several long screws project parallel to the shaft. There is one screw for each tool, and the amount of traverse of the saddle is regulated by one of these screws coming up against part of the bed. The drum can be moved to various parts of the shaft, and firmly

locked there by a trigger. The whole arrangement is very commonly used, and was, we fancy, originally introduced on Gisholt lathes. The device for turning this stop shaft is rather pretty. The annexed sketch, Fig. 5, will give an idea of the arrangement. D is a ratchet wheel with six teeth keyed to the end of the shaft. A is a slotted lever rotating freely on a pin P, and carrying a pawl C, which engages with D. B is a pin fixed to the cross slide, which engages in the slot in A. The forward motion of the cross slide levers sets the ratchet; it is on the conclusion of the backward motion when the turret is revolving that the pawl pulls the wheel round. For screwing and chasing a hob is used. The leading nut, or rather part of nut, is fixed on a lever projecting from a stout weigh-shaft, which runs along the back of the machine, passing through the carriage. A collar on the end of this shaft pulls the carriage forward. The lever for bringing the chasing gear into action passes right under the head, and projects in front. It has adjustment on it to regulate the amount it can be lowered, which can also be employed for taper screwing. The length which can be screwed is, of course, only a few inches. This lathe is fitted with a full wire-feed, and the usual wire-feed clutch and rack. It takes shaft up to 1¼in. diameter, and turns up to 11½in. long. The cross slide has a hard steel projection on it, which can bear up against a former for taper or curved work.

Our illustration shows a front view of the machine. The lever furthest on the left of the operator is for the feed. The uses of the rest will be obvious from the description.

Burton, Griffiths, and Co. have also a machine which is intended for doing any class of screwing work on shafts or

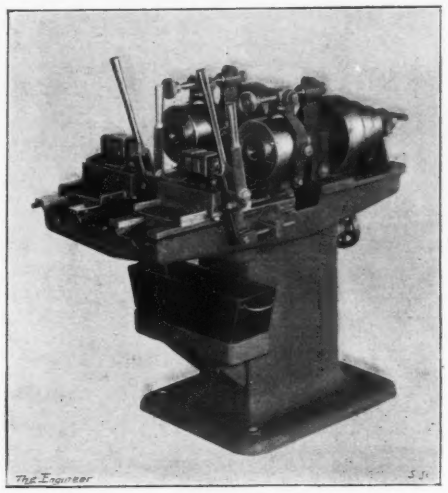


Fig. 6—DUPLEX ACME SCREWING MACHINE

pipes. It is illustrated by Fig. 6. Several sizes of this machine are made. The smallest takes down to ⅜in. shaft, the largest up to 6in. shaft. The machine we illustrate takes a 2in. shaft. The dies are made of steel about ½in. thick, and each one is fitted with a hardened steel cap in the manner shown by the accompanying sketch, Fig. 7. These

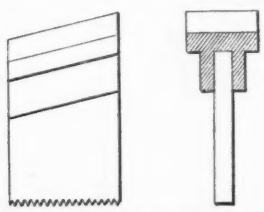


Fig. 7—SCREWING DIES

dies fit into radial slots in the screwing head. Outside them all is a die ring, which has a hardened steel internal conical face bearing on the inclined caps of the dies. The object of the caps is, it will be seen, to increase the surface rubbed by the die ring. It will be readily understood that, as the die ring is pushed forward, it drives all the dies simultaneously nearer the centre. How it is moved so as to do this will be understood best from a diagram, Fig. 8.

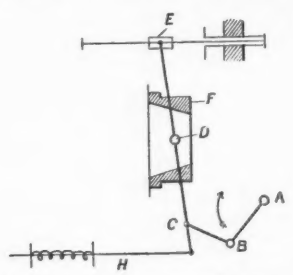


Fig. 8—ACTION OF SCREWING MACHINE

Here F is the die ring; E D C is a lever pivoted at E; A B C is a set of toggles; H, a spindle with a spring on it. In the position shown the toggle is depressed, and the lever pushed back by the spring on H, carrying with it the die ring F. The lever A B is firmly keyed to a shaft A, which crosses the machine. When it is rotated in the direction of the arrow the toggle is flattened out, so as to lock and to press the die ring forward, closing the dies together. The adjustment for the dies is secured in a very neat manner by moving the nut E along the screw seen in the engraving. When heavy square threads have to be made it is necessary that three or four cuts should be taken. To allow of this a second larger screw, which surrounds the smaller adjusting screw, is fitted into the casting above the poppet. It has on it a small hand wheel. It is screwed right out for the first cut; then half-way in for the second; and finally right home to finish.

The carriage has a powerful vice closed by a right and left hand screw, turned by a large hand wheel. A shaft at the back of the machine is pinned to a lever on the end of the toggle shaft A; on it there are two adjustable stops. When the carriage is moved forward so as to engage one of these stops, the shaft is moved longitudinally and bends the toggle out of the straight line. It is immediately thrown right over by the spring rod, and the dies are opened, instantaneously releasing the work. As the saddle is drawn back, it engages the other shaft and closes the dies.

One of the greatest novelties at the show is an automatic machine tool of English design and make, which for ingenuity in design and operation beats anything that has come to this country from the States. It is called an automatic triple-action chucking lathe, and is exhibited by Burton, Griffiths, and Co. As it has only just been completed we have not had time to prepare illustrations of it, but we hope in a later issue to give a full description of it. At present it must suffice to say that it deals with castings up to 4in. diameter, and that three operations, involving as a rule six tools, are in operation at once.

All the machines in Burton, Griffiths, and Company's stands are fitted with a new belt shifter, which they are now introducing for the first time. The principal part of it is illustrated in Fig. 9. It consists of two pieces

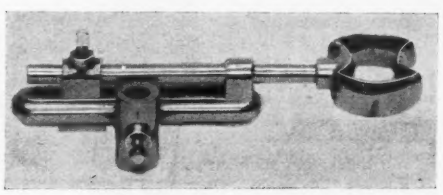
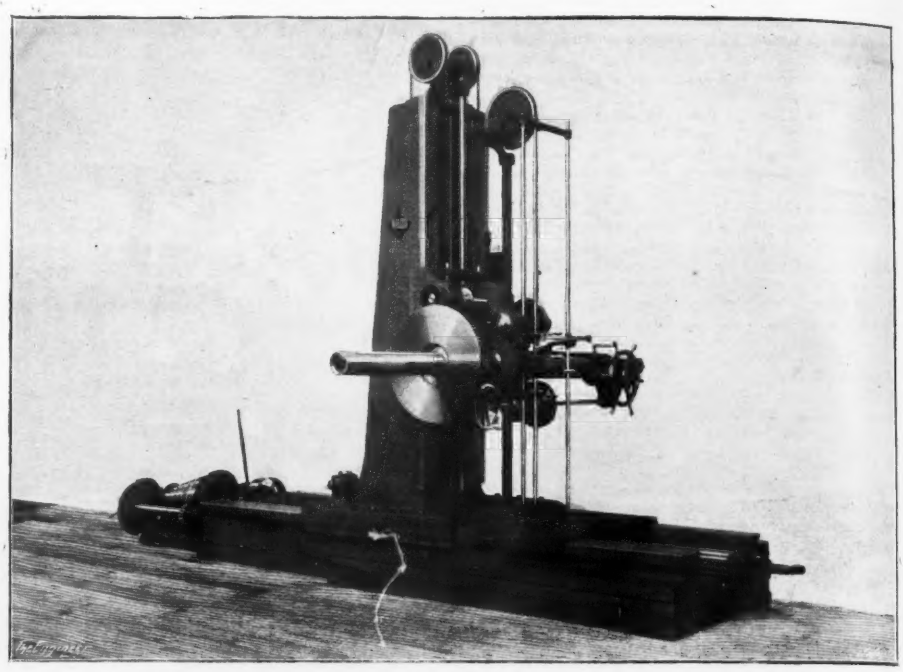


Fig. 9—LIGHTNING BELT SHIFTER

which are free to slide upon each other. At the end of one there is a boss with a hole through it, and a set pin for attaching it firmly to a rod; at the end of the other there is a peculiarly shaped eye through which the belt passes. To fit it to a lathe a vertical rod is erected behind the headstock. The plan recommended is to screw a gas flange to the floor and another to the roof, or a beam vertically above it. These two are to be connected by a length of gas pipe screwed loosely into each, so that the pipe may be free to rotate slightly. The shifter is then attached to this rod at a short distance below the countershaft, the rising side of the belt passing through the eye. A lever is clamped to the gas pipe at a convenient height for the workman. We have watched this simple device in operation, and it is strikingly effective, moving the belt either up or down the cone with the greatest ease. It is one of those simple inventions that make one feel surprised that it had not been thought of and used long ago.

HORIZONTAL BORING, DRILLING, AND MILLING MACHINE

NILES TOOL WORKS, HAMILTON, U.S.A., ENGINEERS



BORING AND MILLING MACHINE.

THE necessity of doing very accurate machining on heavy pieces of work has called into existence many special machines. In another place we describe two portable machines. Above we illustrate a large tool made by the Niles Tool Works, which might be, perhaps, not incorrectly designated semi-portable.

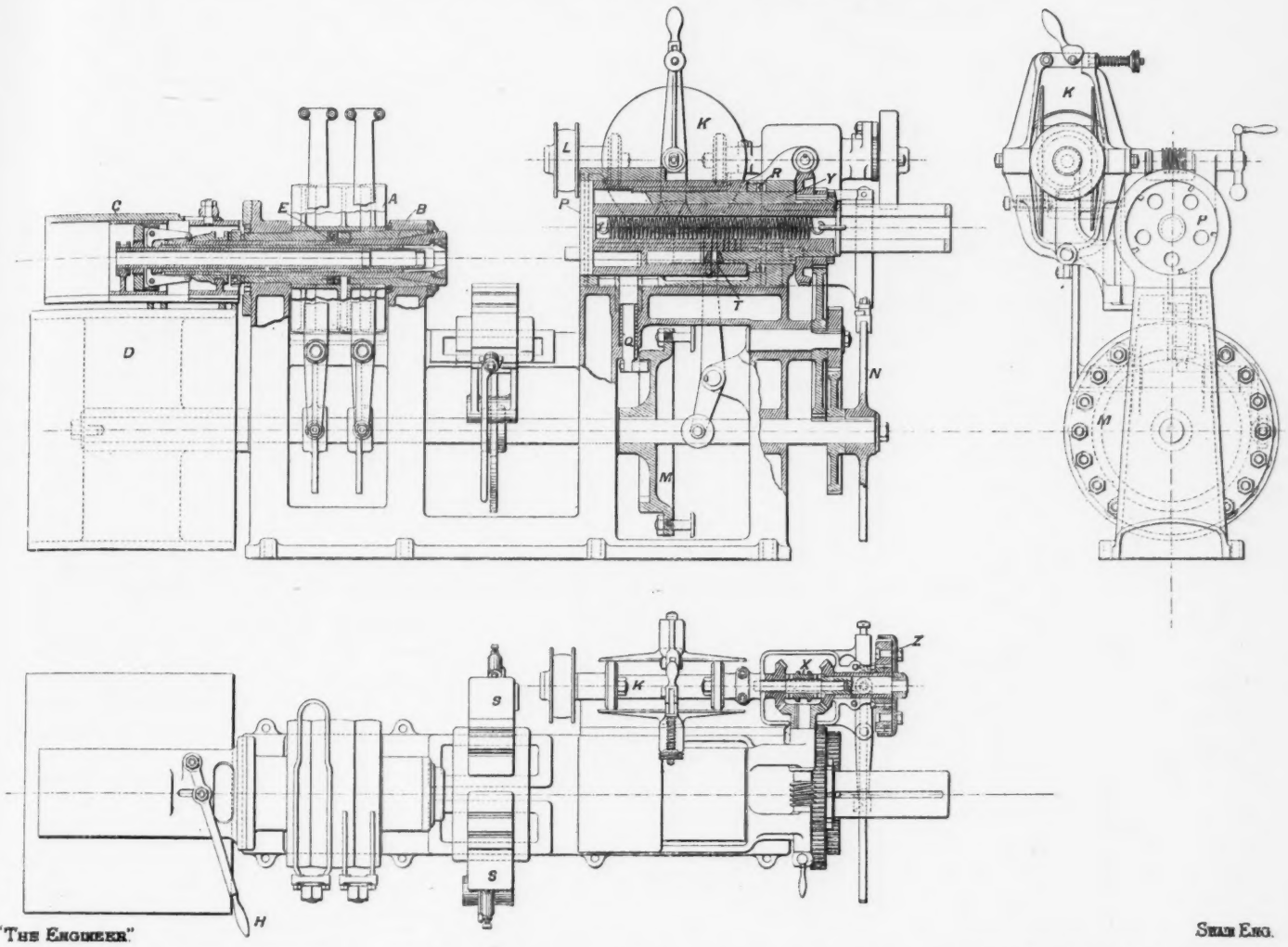
This interesting machine is designed for all classes of boring and drilling, and, in addition, it has ample power and the necessary feeds for milling, doing work that would otherwise require a large planer. The spindle carrying the drill or drilling head may be set out 6ft. from the face of the machine, and it has a horizontal movement of 9ft. or more, and a vertical movement of 6ft. It will therefore finish very large work, and in many cases all the surfaces may be milled and all holes drilled or bored with one setting of the work. In this way a great economy may be effected, as much of the cost of work is due to the time and labour expended in getting the piece into position for the operation, the operation itself perhaps taking but a very short time. To plane a piece of work 9ft. by 6ft. would require a large and expensive planer, with considerable power for moving the work and the table, but with this milling machine the work remains stationary, the tool moving up to its work, and the cut being continuous. It has similar advantages for milling.

The machine consists of a heavy column 10ft. 6in. in height, and 2ft. 7in. wide on the face, mounted on a bed-plate of any required length, along which it is moved by a worm gear and rack, operated by power. On the column is a heavy saddle 40in. square, which carries the spindle, and is raised or lowered by a screw, the vertical traverse of the saddle being 6ft. It is balanced by a counterweight suspended inside the column. The boring and milling spindle is of hammered steel, 6¾in. diameter, and slides on a heavy revolving sleeve. It has a traverse of 6ft., and revolves in either direction—right or left hand—the reversing being effected by a lever convenient to the operator. It has eight power feeds, ranging from $\frac{1}{16}$in. to ¼in. per revolution, and is also provided with a quick return and hand feed. It has six milling feeds, ranging from $\frac{1}{12}$in. to $\frac{1}{96}$in. per revolution of the spindle, these feeds being applied only to the column and saddle and by power only. Any of these feeds for the quick motion may be utilised to set a drill boring bar or milling cutter at work anywhere on the surface which the machine will reach.

At one end of the bed-plate are placed the driving gear, milling feed, and quick traversing mechanism for the column. This latter has a speed of 5ft. per minute, and can also be applied to the vertical setting of the saddle by means of a clutch lever. The driving cone has six steps for a 4in. belt, and is strongly back-geared, giving twelve changes of speed, ranging from 2 to 200 revolutions per minute. It has ample power for boring up to 24in. diameter. A platen or foot-plate is placed in front of the column for the operator to stand on, and all movements of the spindle, saddle, and column can be controlled by levers travelling with the saddle and convenient to the hand of the operator as he watches his work. Tables or floor plates are placed in front of the machine, and may be either flat cast iron plates planed true, or plates having T slots. Compound tables with traverse by screw in both directions, and with circular motion in addition, may also be used.

In machining the bed-plates of blowing engines with one of these machines at the Philadelphia Engine Works, the bed-plate casting was supported vertically in front of the machine. The bearings for the housings and for the steam cylinder were then faced, and the seats for the pillow-block caps were milled, treating the various heights or levels and directions without any change in the position of the bed-plate. The latter was then lowered to a horizontal position, and the main bearings were bored out. The housings of the engines were then bolted together and to stools, and machined and drilled to gauge in a remarkably short time. All the air-valve seats in the heads of the blowing cylinders were bored out without change, the head being 9ft. 6in. in diameter. Spherical joints for patent tuyere stocks, which must be machined accurately, are finished quickly with one cut by means of a simple cutter-head attachment to the spindle of the milling tool of this machine.

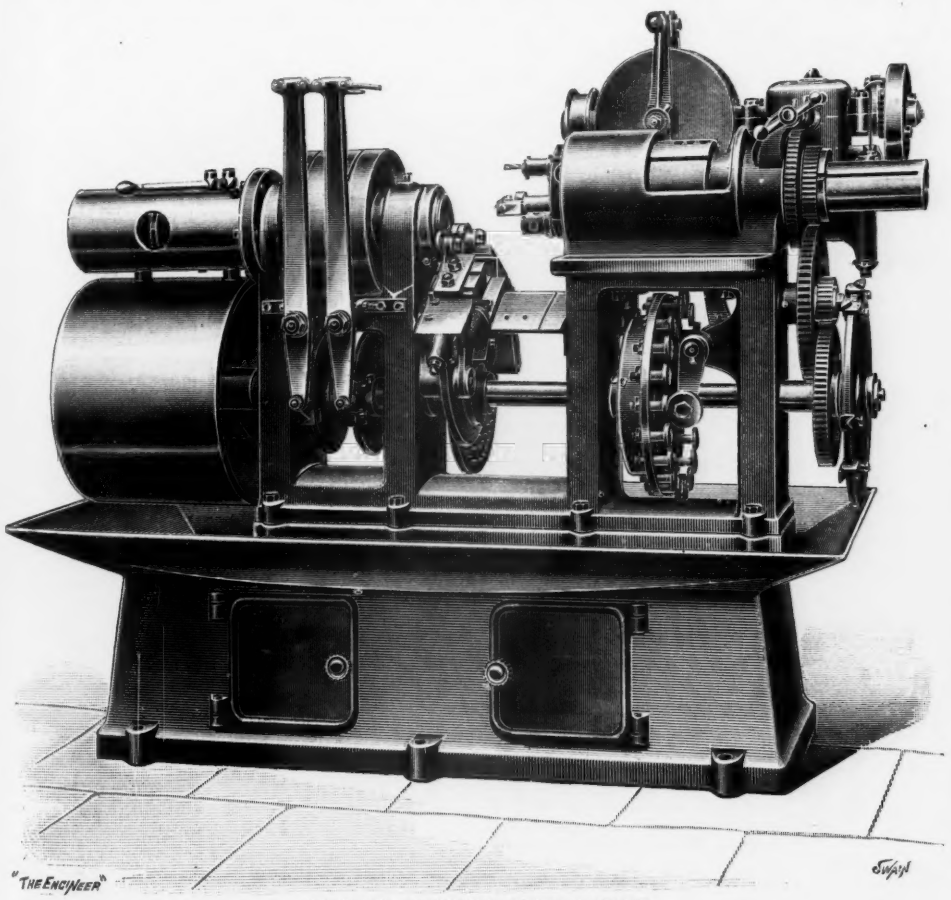
AUTOMATIC SCREW MACHINE



"THE ENGINEER" SHAW ENG.

AUTOMATIC SCREW MACHINE.

An automatic screw machine, constructed by the Wolseley Sheep-Shearing Machine Company, Limited, and exhibited at the Agricultural Hall by C. W. Burton, Griffiths, and Co., is illustrated on this page. It does the usual class of work that is expected from these machines, but has several peculiarities of design which will repay attention. The turret is of the so-called vertical type—that is to say, the face of it is vertical. It has five holes for tools, which can be seen best in the end view marked P. This turret, it will be seen, is a cylinder of considerable length and large diameter, which is free to slide endways in the turret-head. A central tube projects backwards from it, and contains a large spiral spring which continually tends to keep the turret in. Surrounding this tube is a sleeve Y, the front end of which is cut slanting. Against this slanting face a roller T, firmly attached to the turret, is pressed by the action of the spring. On the outside of the sleeve there projects a collar, behind which there is a ball bearing R.



WOLSELEY AUTOMATIC SCREW MACHINE

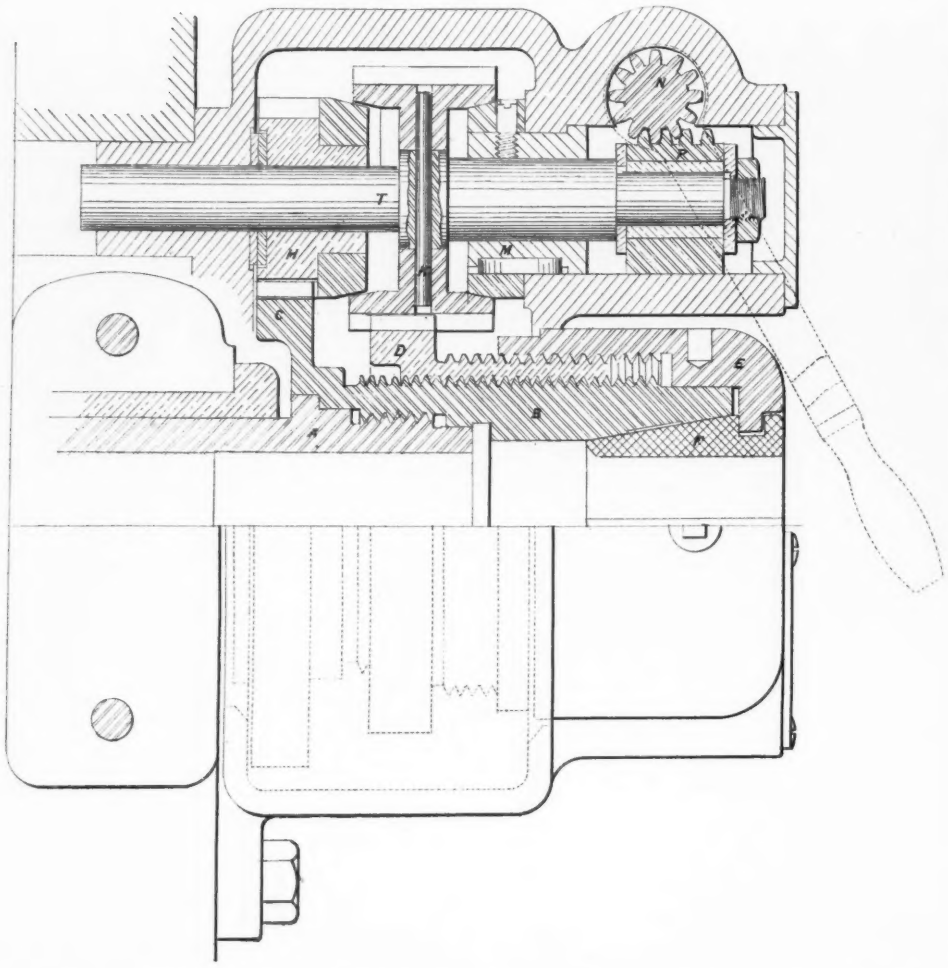
It will be seen, then, that as the sleeve is not free to move backwards, if it is revolved the slanting face must push the turret forward; in this manner the feed is obtained. The method of rotating the sleeve is now to be followed. L is a pulley driven at a constant speed from a countershaft; K is a friction system consisting of a pair of driving wheels and a pair of discs. The discs are held together in the manner shown in the end view; they rotate freely on their spindles, but the spindles are free to rock sideways, so that there is always equal pressure on both wheels and on both sides of them. That is to say, there is no side thrust on the shaft. The driven friction wheel is connected with a bevel wheel set. According as the clutch X is to the right or left, the middle wheel is driven clockwise or anti-clockwise. This wheel is keyed to a shaft, in which is cut a worm driving a wheel keyed on to the sleeve Y. It is to be noticed, however, that the right-hand clutch does not gear into the bevel wheel itself, but into a shaft passing through this wheel and actuating a differential encyclic train, so that the wheel may have a very slow motion. It is, of course, this wheel which effects the feed, whilst the other allows the tool to return at a far higher speed.

It will be observed that the sleeve Y has also keyed to it a wheel which, through a train, drives a shaft on which two cam plates M and N are keyed. The form of cam used in each case will be understood best from the wood engraving. N moves the lever to left or right, and so controls the clutch X. M releases the locating pin Q, to allow of the rotation of the turret, and also, through the lever shown working on the peculiar adjustable cam, alters the position of the friction plates K, and so varies the speed to suit the cut. No special device is required to rotate the turret. Once it is free to revolve, the friction between the inclined path of the sleeve Y and the roller T is sufficient to carry it round till it is again locked by the locating pin.

At the opposite end of the machine there are the arrangements for feeding, holding, and rotating the bar to be operated on. The wire feed calls for no particular attention, as it is of the usual type which has been already described. It should, however, be noticed that the bracket carrying the slides for operating the chuck and feed collets is of a new design, which allows the operating cams to be brought close to the centre line of the spindle, and at the same time forms an efficient guard to prevent damage to the levers, &c. It is also to be observed that the three pulleys A do not rest immediately upon the spindle, but upon a long strong bush. The whole pull of the belts is thus taken upon the bush. A ball bearing E is provided for taking end thrust. There are two levers and two belts, and one belt is moved before the other engages

DIFFERENTIAL SCREW CHUCK

ALFRED HERBERT, LIMITED, COVENTRY, ENGINEERS



the tight pulley, or the spindle can be stopped for slabbing or cross drilling.

The spindle is hardened and ground true all over, and runs in hard cast iron bushes, which also carry the pulleys, and as the pull of the belt is taken entirely on the outside of the bushes, the spindle will run for a very long period without wear. This feature is most essential, and a great advantage to anyone requiring accurate work. The wear on the bearings is usually due far more to the pull of the driving belt than to the pressure from the cutting tools, and unless means are provided to guard against this wear, the spindle will soon get out of alignment and prevent good work being done.

Two cross slides S and S are also provided, and are worked automatically from the cam shaft. Nearly all the operations that can be performed automatically by the machine can also be effected by hand, and a very simple method of throwing the cam shaft out of action by parting the two friction discs K will be understood from the end view.

By the use of change gears placed between the turret and the cam shaft underneath, the turret may be set to stop at only those holes which are necessary for the work in hand. For instance, the turret may have four holes, and the job only requires two holes to finish it. By fixing on the gears sent for two holes the other holes are passed, and all the other cams speeded up in proportion. This not only means less wear, but is the means of saving a very considerable amount of time.

Reviewing this machine as a whole, it will be admitted that it has many excellent points. The idea which the designer has evidently had in mind throughout is to get the line of pressure as near as possible to the line of work, and thus to obviate the tipping action, which not only increases friction but accelerates wear. Thus, the turret is moved forward by a pin which is not far from its centre, and the feed cam is brought nearer than is usual to the centre of the bar. We may notice also that the locating pin acts on a point further out from the centre of the turret than the tool, so that the chances of accuracy are increased. That ample wearing surfaces are provided will be evident from the drawing, and that the fitting and adjustment is good we can assert from careful inspection of several of these machines at work. The convenience of the workman has been carefully considered, and provision against unnecessary wear and absorption of power has been made in the supply of efficient means of lubrication, and ball bearings to take up thrust.

HERBERT'S DIFFERENTIAL SCREW CHUCK.

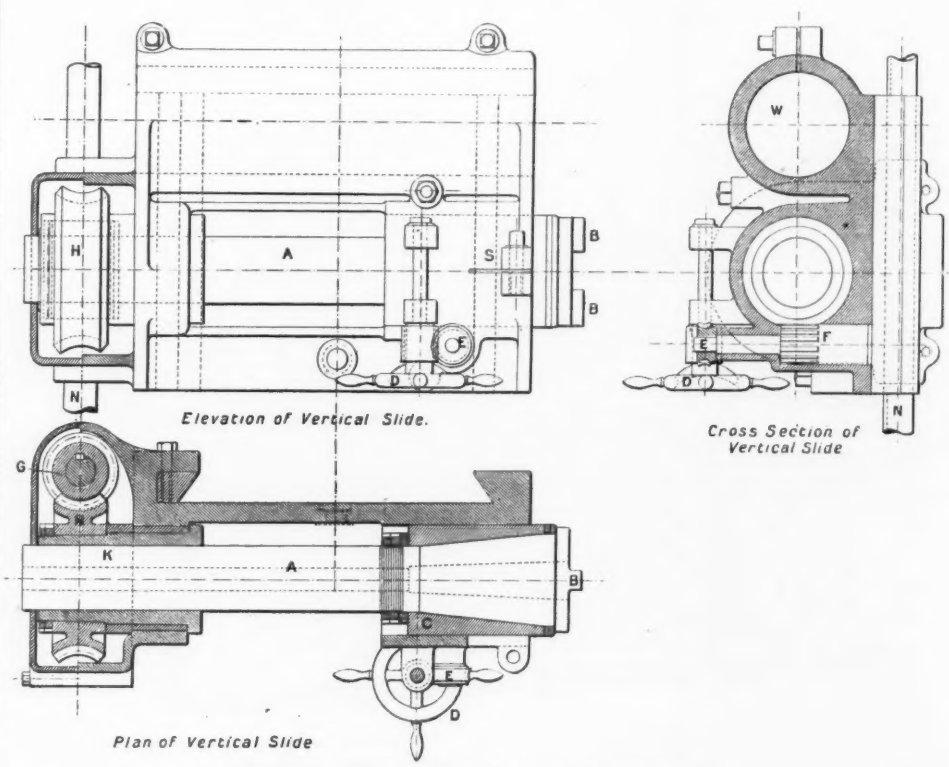
We have dealt already at considerable length with the principal machine which Alfred Herbert, Limited, exhibit at the National Show. Of the smaller machines which they make we may be able to write at another time; but it will be as well to take this opportunity of describing a very ingenious chuck which they are now fitting to their automatic machines. It has been produced to meet the objection to the common type of chuck, that its range is too small to allow of its being used satisfactorily on ordinary rolled bar, which frequently varies so much in diameter from one part to another that the jaws will not grip it. Herbert's chuck is illustrated above. There are four separate jaws, which can be removed through the hole in the cap to be replaced by different sizes to suit different stock. They are of hard steel and fit into a cone of hard steel carefully ground up dead true. The power of the clutch is such that the taper of this cone can be made much steeper than is usually the case, and thus the range of the chuck is increased. It operates as follows:—

A is the end of the spindle. B is the nose piece screwed fast to it, coned out dead true at its front end and hardened. The spur wheel C is cut from it solid at the other end. B has an exterior thread cut on it which fits the female thread of a bronze nut D. Part of D is also formed into a spur wheel, but of smaller diameter than C. It is screwed also on the outside and fits the cap E. This cap carries the four jaws F of the chuck. C engages a wheel H on a shaft T parallel to the spindle. Part of H is formed into a friction clutch. K is a long spur wheel keyed to the shaft T. It is turned inside the rim on each side to form a friction clutch. M is a circular steel piece rigidly fixed to the casting. The shaft T can be moved endways by the wheel N and rack P, so that K engages with either H or M. Now D is threaded internally with a different number of threads to what it has externally—say six threads inside and five outside per inch. If it is revolved then it will travel outwards along B less rapidly than E will travel inwards along it, and the gain of force pulling E in will be very considerable. The manner in which D is rotated will be readily understood from the drawing. C, as already explained, revolves with the spindle, and of course drives H always. Now if K is pressed to the left it revolves with H and so drives D, and because of the ratio of the gearing at a higher speed than C is revolving at, but in the same direction. Thus D rotating faster than B runs out along it, and at the same time draws E in as already explained, and grips the bar. But if K is pressed to the right against M, known at Herbert's as the "static clutch," it can no longer revolve. D is therefore also unable to turn, but as B turns in it, it is rapidly pushed outwards, the pieces F are withdrawn from the cone, and the bar is released.

This chuck is now being fitted to all the smaller size of machines which the firm makes. It is shown on the lathe illustrated on page iv. It has had already a prolonged trial in the works at Coventry, and has proved very efficient. As an indication of its power, we may mention that in the early forms the working lever was made so long that it extended well across the machine. Experience has shown that this great length is unnecessary, and only quite a short and light lever is fitted now. Although such a chuck is unquestionably superior to one with a short range, the reason which led to its adoption is one which need scarcely have arisen. Such a chuck, for example, would hardly ever be required in the States, where the bar used is of far greater regularity than those rolled in this country. In the States a practically bright bar is sold at such a price that it can be used economically. In this country it is almost impossible to get makers to roll such bars, and although they can be imported at a fairly cheap rate, it is generally found more advantageous to use the rolled black bar, which can be readily purchased.

MILLING MACHINE WITH HORIZONTAL AND VERTICAL SPINDLES.

The two engravings on p. xi., and the drawings on this and the next page, represent a powerful milling machine which has recently been completed by the Wolseley Sheep-Shearing Machine Co., of Alma-street, Birmingham, and which we were invited recently to inspect. It is a machine of large size, with particularly broad wearing surfaces, and of great strength and rigidity in all its parts. The bed is of deep box form, 11ft. long, 18⅜in.



WOLSELEY MILLING MACHINE—Fig. 1—HORIZONTAL SPINDLE

MILLING MACHINE WITH HORIZONTAL AND VERTICAL SPINDLES

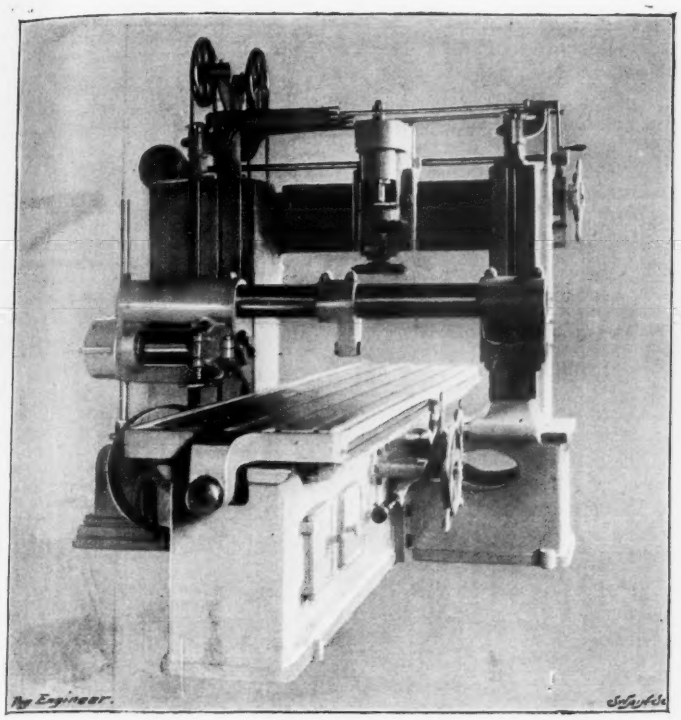


Fig. 2—FRONT VIEW

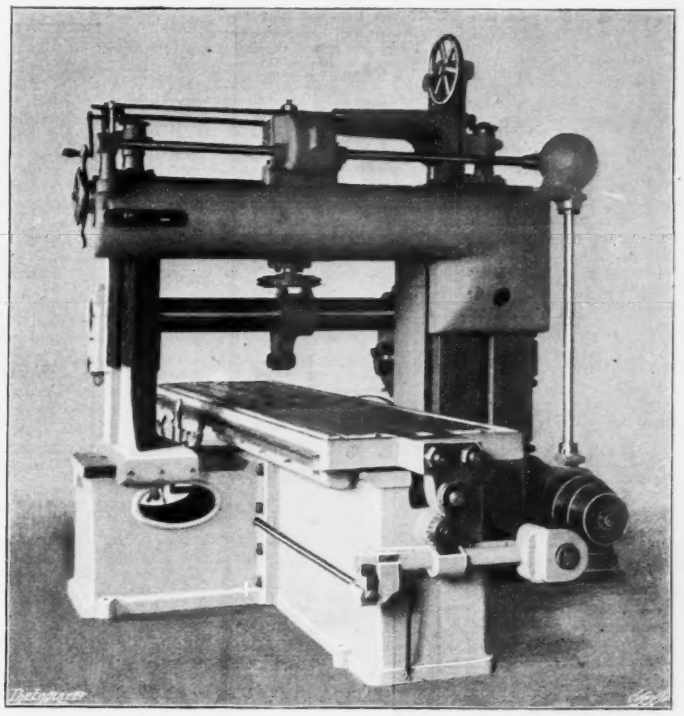
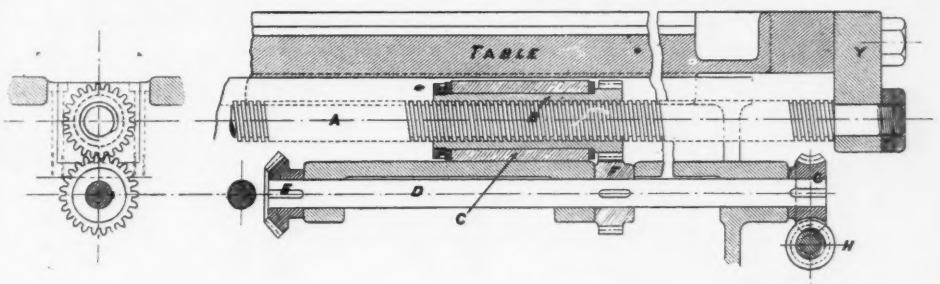


Fig. 3—BACK VIEW

wide on the slides, and 2ft. 2in. deep. It carries a table 10ft. long by 2ft. wide, and 4in. thick. It will take between the headstocks a maximum width of 3ft. 10½in., and the centre of the horizontal spindle can range from 2in. above the face of the table to 1ft. 6in. from it. The vertical spindle has a cross traverse of 3ft. 6in. The poppet bar, or cross steady is 6in. diameter. Both the horizontal and vertical spindles are adjustable vertically, and the outboard bearing is adjustable sideways, or can be removed entirely to allow pieces too large to go between the standards to be machined. Clamps are provided throughout for rigidly holding the various parts in desired positions. The travel of the table is stopped automatically by the worm which drives it being dropped out of gear with the wheel. The worm in its box is kept up by a wedge on the end of a rod, seen best in Fig 3. A stop on the table throws over a lever which pushes back the wedge, and allows the worm to fall. The driving cone has three steps, and takes a 3½in. belt.



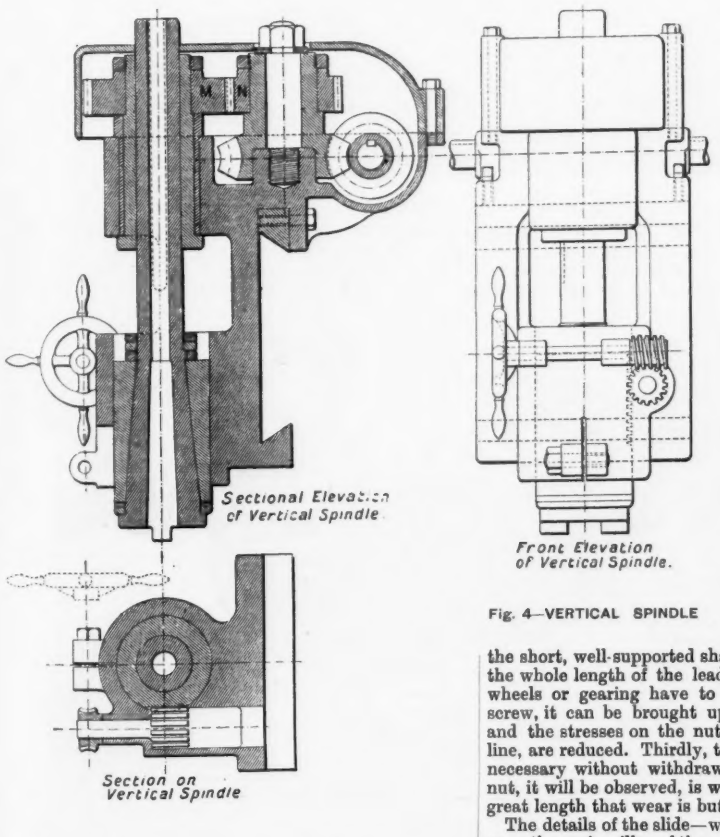


Fig. 4—VERTICAL SPINDLE

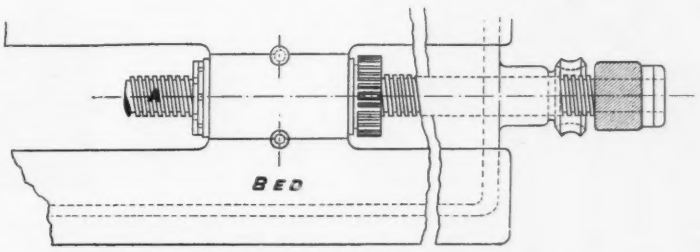


Fig. 5—TABLE SCREW AND NUT

Fig. 5 shows the means by which the table is traversed. A is the leading screw, 2½in. diameter, ½in. pitch, part only of which is shown; it is rigidly attached to the table by the yoke Y, and is not free to rotate. B is the long traversing nut, made of a hard bronze. It fits into the long bush C. This bush is rigidly attached to the bed in the manner shown in the plan and in the end elevation. D is the driving shaft. It can be driven either through the pair of bevel wheels at E by hand, or through the worm and wheel H and G. To this shaft a spur wheel F is keyed. F gears with a wheel cut solid on the end of the nut B, and so rotates it. Hard steel adjustable wearing washers are provided at each side of the nut. Examination of the drawing will show the advantages of this arrangement. In the first place, it involves less work to turn the short, well-supported shaft D than it would to turn the whole length of the leading screw. Secondly, as no wheels or gearing have to be attached to the leading screw, it can be brought up very close under the table, and the stresses on the nut being kept in a more direct line, are reduced. Thirdly, the nut can be removed when necessary without withdrawing the leading screw. The nut, it will be observed, is well supported, and is of such great length that wear is but slight.

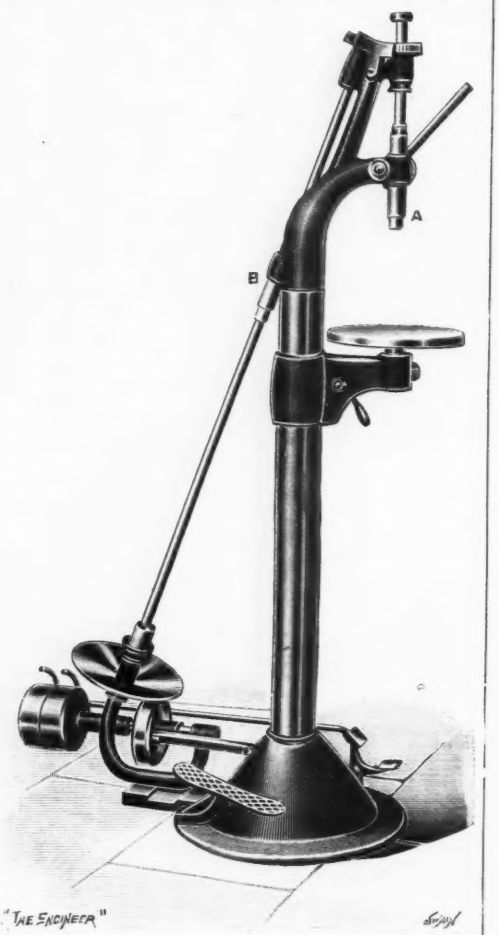
The details of the slide—which can be raised or lowered upon the main pillar of the machine—are seen in Fig. 1 on the preceding page. Here A is the spindle; it has a hole bored right through its length, is coned out at the front end, and has the driving lugs B B cut on it. These lugs fit into suitable notches in the end of the mandril or miller shaft when it is in position. The cone portion fits a long bronze bush C. This bush fits a round hole in the casting of the slide, but on its lower side a rack is cut, into which the pinion F, end view, gears. On a solid extension of F is keyed the little worm wheel E, which can be rotated by a worm on the spindle to which the hand wheel D is keyed. Thus, the bush can be moved in and out to a slight extent to give fine cross adjustment. It can be clamped when desired by the screw S. The other end of the spindle A also passes through a long bush K carrying a worm wheel H. A feather joins K and A, but K is free to revolve in the long external bush. The worm G is driven by the vertical shaft, in which is cut a feather way. The upper part of the casting W is arranged for carrying the poppet bar for outboard support in particular cases. The width of the slide, and the solid manner in which the adjusting key is fitted in, will be noticed. The worm and worm wheel G and H are covered by a casting which makes a tight joint with the slide casting, so that an oil bath is formed.

Details of the horizontal slide and vertical spindle are given also, Fig. 4, but as the arrangement very closely resembles that just described, it need not be gone into so fully. It will be noticed, however, that the worm, instead of driving the spindle direct, does so through a pair of wheels M and N. These wheels are not of the same diameter, but they are interchangeable on the spindles, so that a change of speed can be obtained. The worm works here also in a bath of oil. The adjustment for height is precisely similar to the horizontal adjustment on the other slide.

It will be seen by an inspection of the engravings that the machine throughout has been designed with such large wearing surfaces, and the parts are all proportioned on such a large scale, that wear should be slight, and even with the heaviest cuts the machine should be rigid and accurate.

SENSITIVE DRILLING MACHINES.

At the Stanley Show Charles Churchill and Co., Limited, Leonard-street, Finsbury, exhibit two very handy friction-driven drills. In the use of the first the hands



FRICTION DRILLING MACHINE

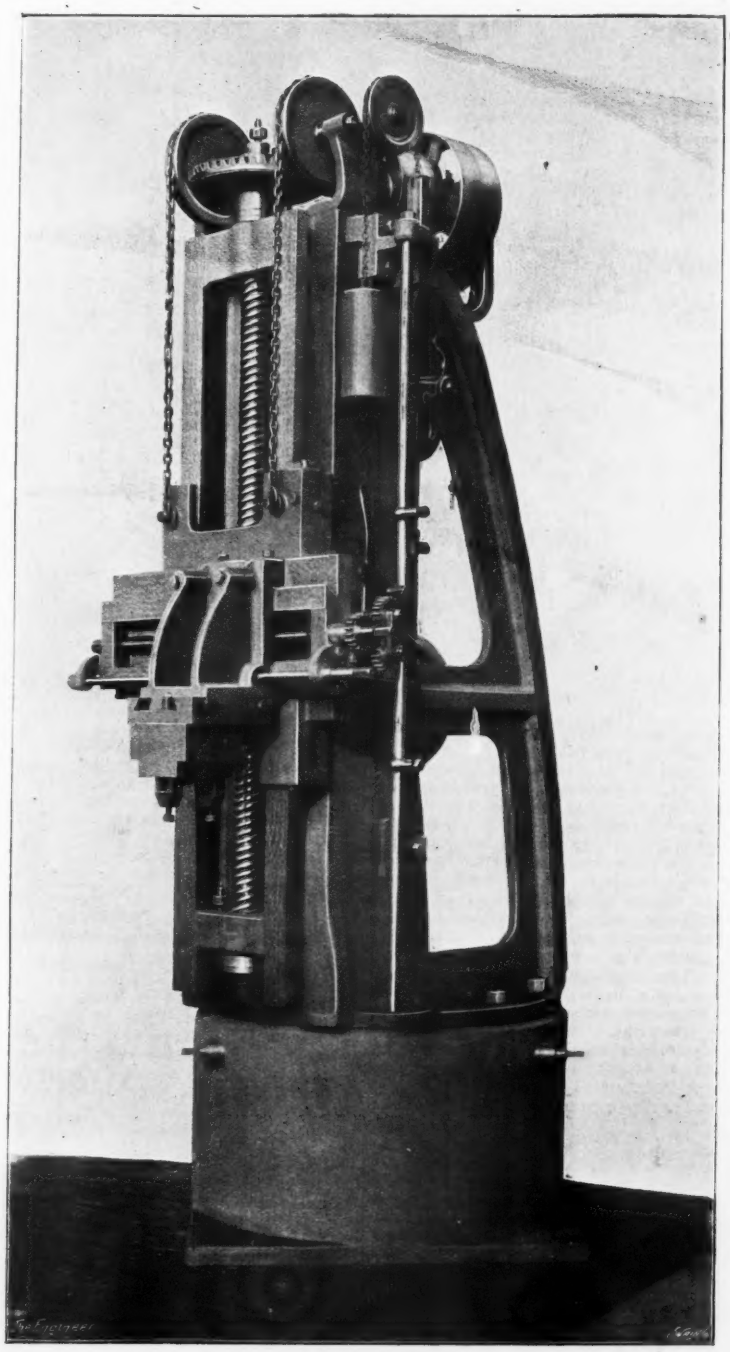
are perfectly free to attend to the work. The belt is moved from the loose on to the fast pulley by the treadle on the right side of the machine. The treadle on the left or

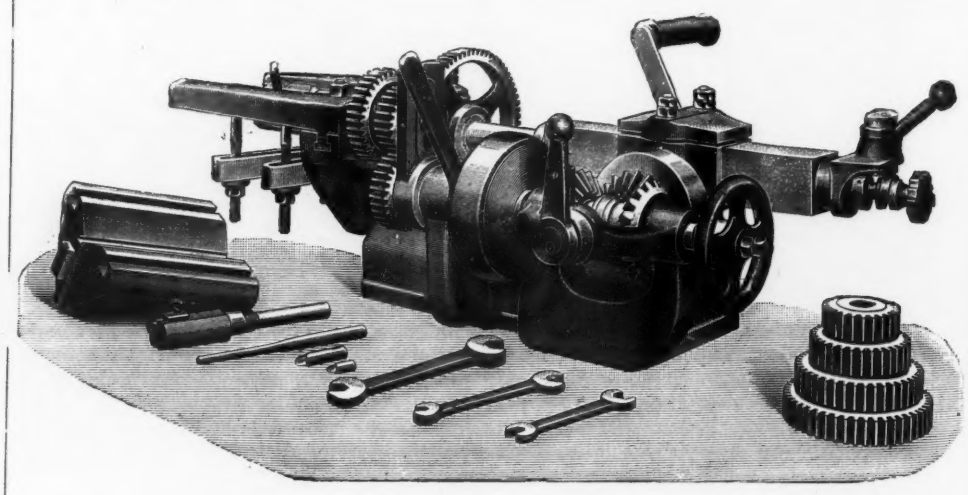
SENSITIVE DRILL

near side regulates the speed by moving the friction wheel backwards and forwards on the coned friction disc. The transmission, it will be observed, is almost direct to the drill, so that the loss of power is small. There are, moreover, ball bearings at A and B. The drill is fed by a lever, which works in a kind of ratchet, so that a quarter turn of it releases it for a new catch. The table rises and falls on the pillar and can be clamped in any position. The greatest distance it can be placed from the table is 34in. The vertical range of the spindle is 5in., and it takes drills up to ¾in. The diameter of the column is 3⅜in. The machine shown in the second figure is more pretentious. It is also a friction sensitive drill, but the leather friction roller is in this case put in the head of the machine between two cones, and power is transmitted by a twisted belt. This arrangement, being less direct, is probably more extravagant of power than is the other drill. The speed of the drill is altered by sliding the frame in which the friction roller is mounted. The rod on which it is moved is graduated to show

PORTABLE SLOTTING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS





OIL GROOVE CUTTING MACHINE

the correct positions for drilling cast iron. The amount of power transmitted to the drill can be rapidly regulated by turning a hand wheel beneath the lower cone, which raises and lowers it, and so increases the friction. The spindle cone is fastened to a long sleeve or bush which passes through both bearing, and through it the spindle itself passes, and is by this means relieved of all lateral pressure. The end thrust is taken up by a ball bearing. Graduations are marked on the sleeve to show the depth drilled, and a collar can be made fast on the spindle, so that a number of holes of the same depth may be drilled when desired.

The square table shown in position may be swung right out of the way, and the round table fixed on the adjustable bracket, which has a vertical range of 28in., the maximum distance being 42in. from the end of the spindle. The spindle head itself can be adjusted vertically 13in., and the throw of the spindle is 3⅛in. The machine takes drills up to $\frac{9}{16}$ diameter. The distance from the centre of the spindle to the column is 6¼in. The feed is again given by a side lever. We have tried both machines, and have found them well up to their work. Their handiness is remarkable.

BURTON OIL GROOVE CUTTING MACHINE.

To anyone who has cut or seen cut the oil grooves in engine brasses, it must have occurred that a better means than the use of hammer and bent chisel could be found, and in a good many shops special arrangements have been devised by the staff for cutting such grooves. Burton, Griffiths, and Co., are now introducing a machine devoted specially to this work, which has many good points. In the first place, it is quite portable; secondly, it is independent of power supply, being operated by hand; and thirdly, no marking off of the brass is required

An illustration of it is given on the opposite page. The brass to be operated on is fixed in the clamps seen at the left end of the machine. The tool is fixed in a carrier at the end of a bar, which is caused to reciprocate by working a handle. At the same time a rotary motion can be given to it at any part of the stroke by throwing a friction gear into action, and by means of variable speed gear the pitch of the spiral so cut may be made any desired amount. A reversing gear is provided also, so that a left-handed groove or crossed grooves may be cut without moving the brass. The tool carrier is moved in and out from the bar by a steel wedge operated either by the lever or by the hand wheel at the end of the bar. The lever is used for throwing the tool in at the desired point of the stroke, whilst the hand wheel adjusts the depth of the cut. Various forms of chocks for mounting brasses are provided.

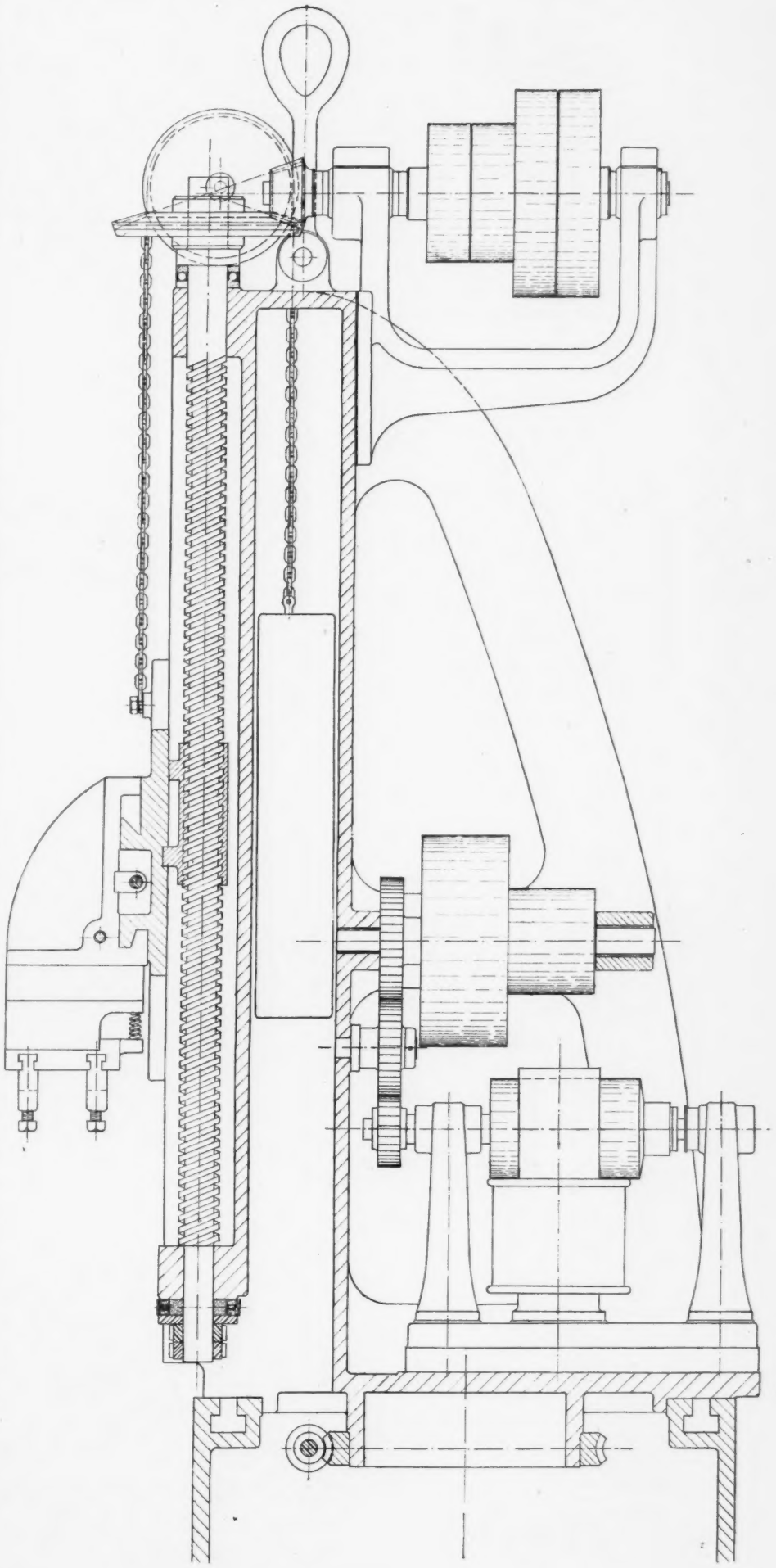
PORTABLE SLOTTING MACHINE.

We give an illustration of a portable electrically-driven slotting machine, made by Joshua Buckton and Co., Limited; also a vertical section of the machine, which shows clearly the position of the electromotor, and the arrangement of the drive between the motor spindle and the driving pulleys of the machine, and it also shows what is an important detail in a portable tool, viz., a fixed loop on the top of the standard placed vertically above the centre of gravity of the machine, and shaped suitably for a crane hook to go freely into it, and thus, with the least possible trouble, transfer the machine from one position to another, and put it down plumb on to any part of the floor plates to which it is cramped for working. This machine is a very good example of an important class of machines, viz., those which are brought to the work which requires tooling, as distinguished from the more numerous class of machine tools which are stationary themselves, and to and from which the work requiring to be tooled is conveyed and removed. In a shop that is well equipped with travelling cranes, it may be broadly stated that the latter has hitherto been by far the more important class of tools, but the use of an electric drive greatly facilitates the application of the portable class, especially where work is of such magnitude as to be larger and heavier than the machine which tools it, as is undoubtedly the case with the magnet frames and commutators of Siemens Brothers, for whom Joshua Buckton and Co., Limited, have made the tool now illustrated. The scheme and design of the tool has emanated from Mr. Dumas, on the staff of Siemens Brothers, and that firm are going further in the same direction. They have ordered from Joshua Buckton and Co., Limited, another portable machine, designed for horizontal drilling, tapping, boring, and milling. This develops a further advantage that must be placed to the credit of the portable class, which is, that the progress of heavy work through the shop can be expedited by completing two operations upon it at the same time instead of taking them one after the other. Suppose, for example, that the slotting of a heavy magnet frame occupied 100 units of time, and that the drilling, boring, tapping, and milling also occupied 100 units of time, it would seem that by bringing two efficient portable tools to bear upon the same piece of work, the whole of these operations might be done in 100 units of time instead of occupying 200 units of time, as would be the case were the work removed from one fixed machine to another, so as to complete the different operations in sequence instead of taking them simultaneously.

We will now describe more particularly the capacities of the portable slotting machine illustrated. It has a variable stroke up to a maximum of 4ft. 6in., and the tool box has a self-acting transverse feed of 2ft. 6in. The framework carrying the slotting head is all in one casting, and the front part of it forms a box which encloses a weight to counterbalance the slotting head. The slotting head is driven down at a cutting speed of 17ft. 6in. per minute, and it runs up on the idle stroke at a return speed of 54ft. per minute. The whole of the framework can be revolved by a worm and worm wheel motion upon a circular race carried on a square base plate, thus when the machine is secured by its base plate upon the floor plates of the shop, the slotting head can be adjusted into parallelism with the seatings to be tooled by the circular motion described. The machine is driven by Siemens' H 8/7 motor, 115 volts, 720 revolutions, 5 brake horse-power. The motor drives through cut steel gearing on to a self-contained countershaft, which by cross and open belts drives the bevel gear actuating the screw which works the slotting head up and down.

ELECTRICALLY-DRIVEN SLOTTING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS



The sectional engraving shows clearly the arrangement of the motor and countershaft, and also shows the loop at the top of the machine for the ready admission of a hook for lifting the machine. It is obvious that with such a self-contained machine, capable of being moved over a large area without disconnecting it from the electric current conveyed to it by a light cable, much less time would be lost in shifting the position of the machine, and bringing it to bear upon its work than would be the case if the machine needed to be driven by belt connection with shafting or by steam connection with a self-contained engine. The machine is suitable for taking heavy cuts, the driving screw being 3½in. diameter, and the power sufficient for a depth of cut of 1in. in mild steel.

COMBINED TRAVELLING CRANE AND RADIAL DRILLING MACHINE

THEODOR BELL AND CO., KRIEUS, ENGINEERS

Fig. 1.

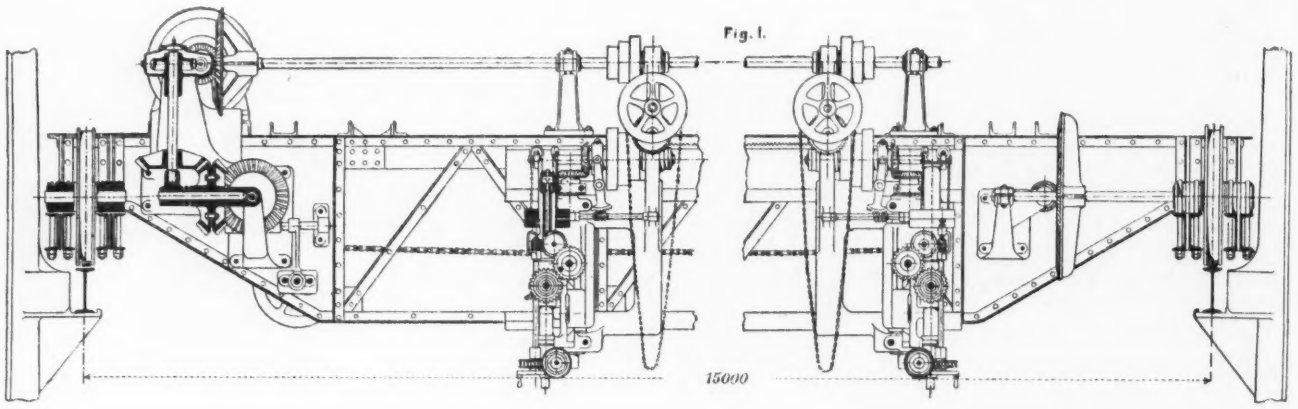


Fig. 2

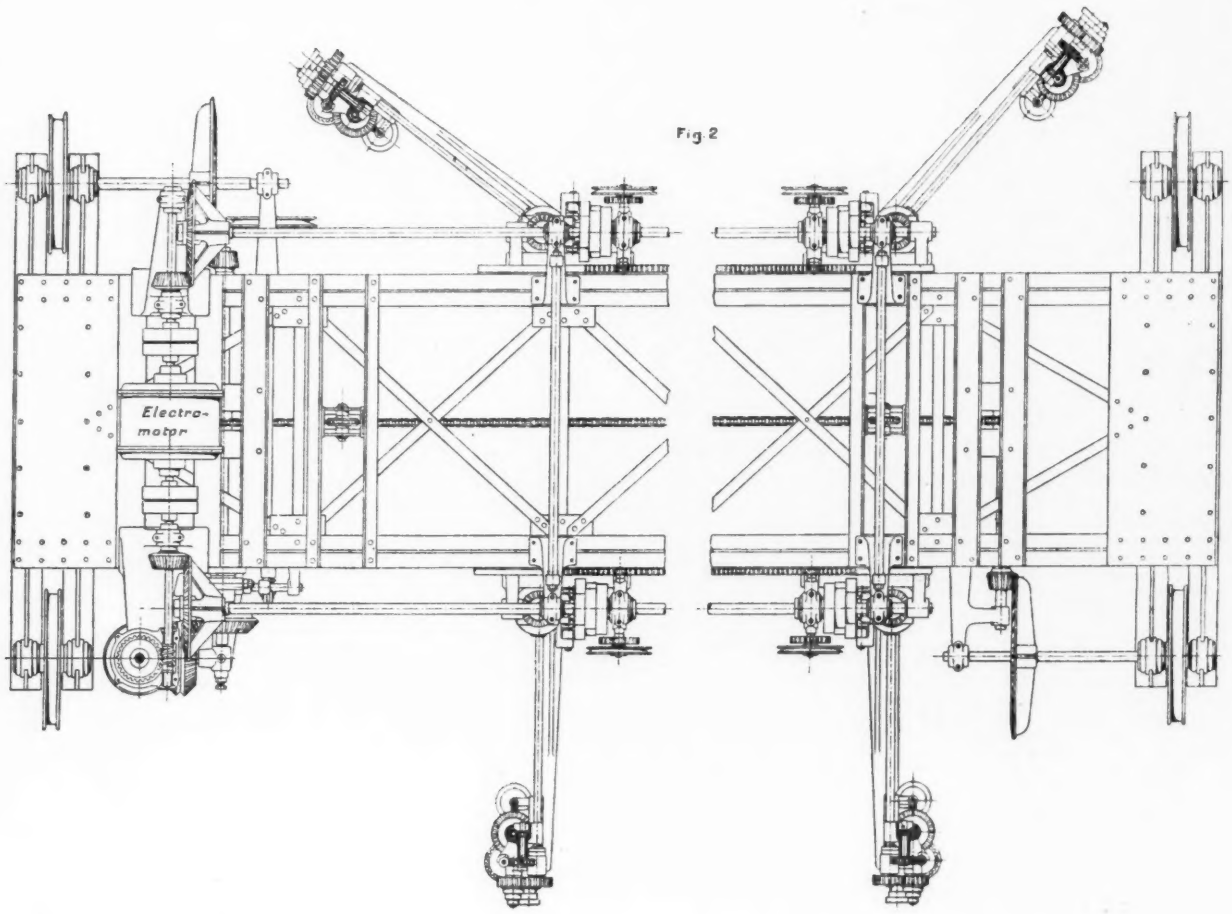


Fig. 3.

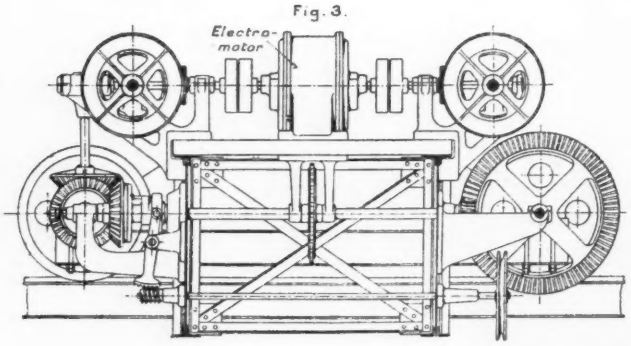
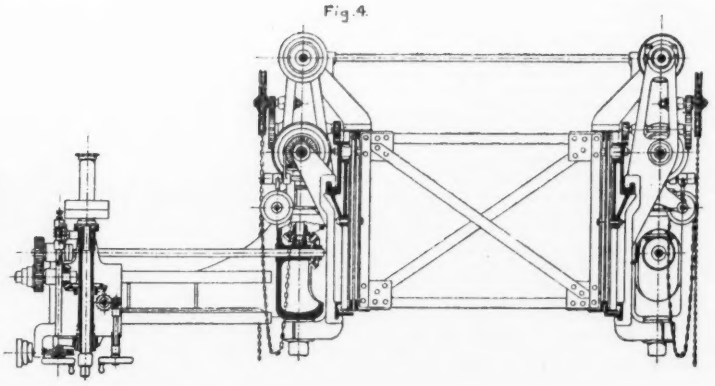


Fig. 4.



A TRAVELLING DRILLING MACHINE.

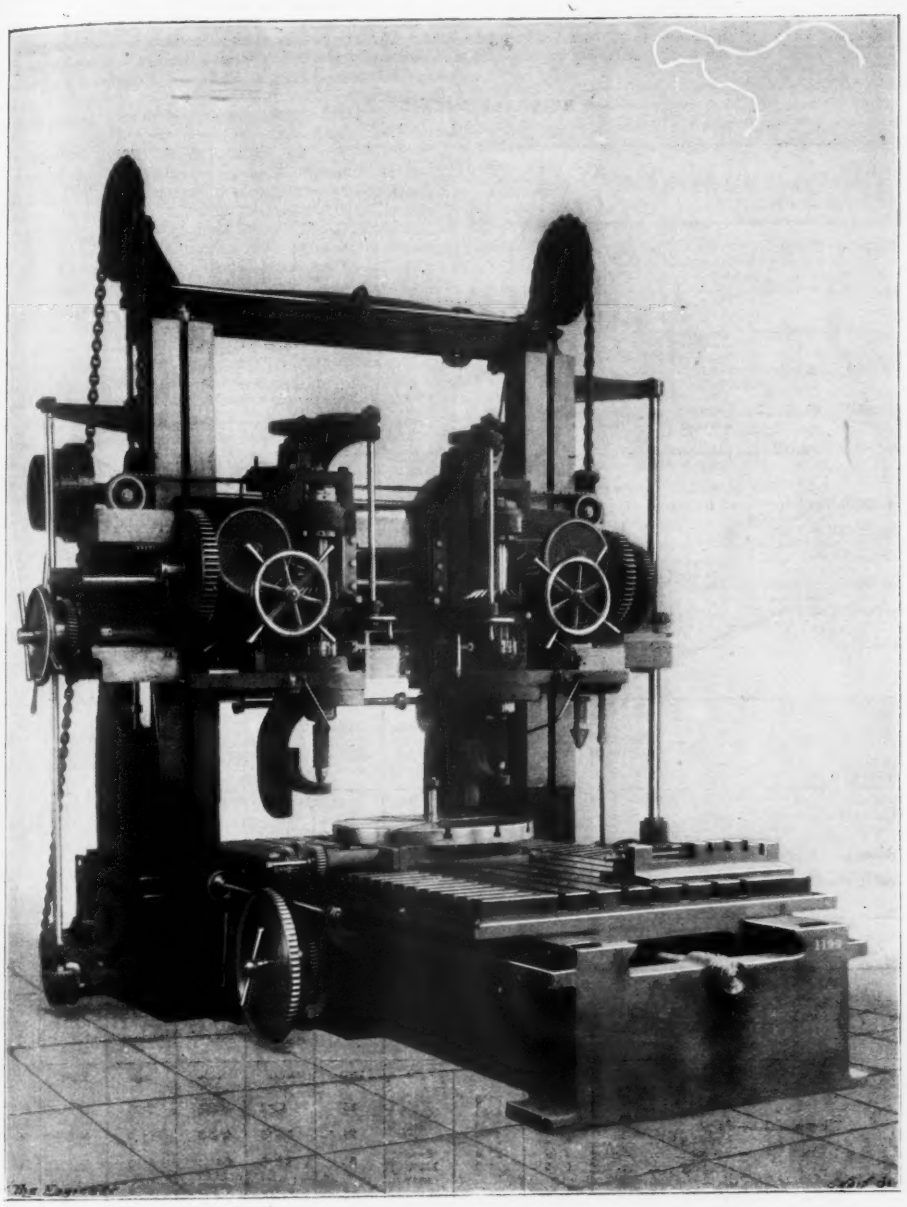
THEODOR BELL AND CO., of Krieus, near Lucerne, have recently built a quadruple drilling machine for use in their bridge-building works—which serves the double purpose of a travelling crane and a machine tool. The area commanded by the four drilling heads is 65 metres by 15 metres, and, moreover, the four heads are up to a certain extent independent of each other. The carriage which carries the drilling machines is similar to a travelling crane; it consists of two parallel lattice-framed girders with solid ends, which can be made of very light scantling as they have only their own weight and that of the four drilling machines to carry. Our illustration is reproduced from the "*Zeitschrift.*"

The framing has a span of 15 metres, is one metre high, and 1·4 metre broad. An electro-motor, attached to one side of the framing, receiving a direct current of 240 volts, and making 780 revolutions per minute, works the traversing motion as well as the rotation and feed movements of the drills. Two horizontal shafts on the long sides of the carriers, making 300 revolutions by bevel gearing, work the drills through two step pulleys, giving three different speeds of 77, 118, and 176 revolutions per minute. A friction coupling is inserted on the shaft of the lower step pulley, so that each drilling head can be started or stopped independently of the others. The maximum diameter of hole bored is 50 millimetres (2in.) The feed of the spindle is effected by a belt with a three step speed pulley. When the automatic feed is thrown out, the spindle, which is counterpoised, can be easily raised and lowered by the hand wheel. The drilling arms, which commands an effective radius of 1·2 metres, are moved by hand, and the drilling head is moved horizontally in the same way by a rack-and-pinion movement.

For the second function of the electro-motor, namely, the traversing of the machine frame along the whole length of the shop, a shaft carrying a worm driving a vertical shaft is provided whose motion is communicated to one of the axles of the carriage by three pairs of conical wheels. Between the second and third pairs of these wheels a friction coupling is inserted, which is actuated by a chain wheel. In order to keep the frame straight it is necessary to drive from both ends, and therefore the vertical intermediate shaft carries a driving chain to a corresponding shaft at the other end where the motion is transferred by bevel gearing to the driving axle. The frame is made to move in one or the other direction by reversing the direction of the electro-motor. The speed of movement is about 10 metres per minute.

DOUBLE-SPINDLE MILLING MACHINE

WILLIAM MUIR AND CO., LIMITED, MANCHESTER, ENGINEERS

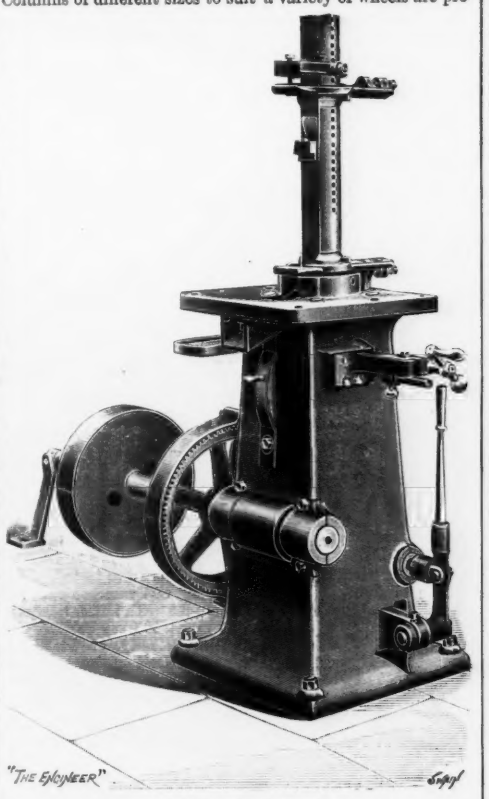


DOUBLE-SPINDLE MILLING MACHINE.

THE illustration above is reproduced from a photograph of a double-spindle profiling and general milling machine, with rising and falling cross slide, recently built by William Muir and Co., Limited, of Strangeways, Manchester, for the locomotive building shops of one of the principal railway companies, and specially designed for milling two connecting-rods at the same time from one former plate. Amongst the noticeable features of this machine are the spindle slides, which are fitted with spindles 4in. diameter, and provided with Alfred Muir's patent couplings for readily securing and releasing the mandrils, for cutters, and constructed to work independently or simultaneously. For this purpose each carriage is arranged with disengaging motion, so that one or both can be worked or stopped from the one driving shaft, and arrangements are also provided for coupling both carriages together by means of an adjusting screw for profiling in unison along the sides of two sets of work from one former plate. The cross slide is balanced and raised or lowered by power. The machine is provided with practically two tables. The main one is a rectangular table with T slots, and provided with troughs all round the outer edge, to drain away the lubricant back to the cistern in the bed of the machine, and is fitted with self-acting longitudinal reversing hand-feed motions, also with quick traverse in either direction by power. This table is 10ft. long by 5ft. wide, and the machine will admit 5ft. 6in. between the uprights and 5ft. in height between the cross slide and the table. The subsidiary table is circular, and 3ft. in diameter, arranged to fit on the rectangular table, from which it can be readily removed when not required. This smaller table is self-acting by worm and wheel. The cutter stays are arranged to take cutters 9in. diameter by 13in. long; all the slides are fitted with index rules, and a centrifugal pump is provided for lubricating the cutters. The machine is of massive construction, the total weight being about 25 tons.

KEY SEATER.

A MACHINE for cutting keyways in the hubs of wheels is exhibited at the Stanley Show by Burton, Griffiths, and Co. It is illustrated herewith. It consists of a vertical column rising from a table. The wheel is dropped over this column on to a stepped part at its base which fits the hole in the hub; a top clamp, which also fits the hole, is then brought down and holds the wheel fast. A slide which moves up and down in the column carries a tool just the width of the keyway to be cut, which is fed forwards by a hand wheel. Columns of different sizes to suit a variety of wheels are provided. The parings fall down and out by a shoot at one side of the column.



GIANT KEY SEATER

THE WORK OF MACHINE TOOLS.

THE following is an abridged translation of a paper on "The Work of Machine Tools," contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, by Messrs. F. Hillier and Ch. Frémont:—

The authors commenced their investigation by taking steps to find out the amount of power required to overcome the friction of a machine, caused by the pull of the belt. This amount will evidently be different when the machine is running light and when it is doing work, because the tension on the belt is not the same in both cases. The increase of friction is different for each machine, and varies in any one machine at different periods. These variations are due (1) to the quantity and quality of the lubricants; (2) to the amount of pressure on the rubbing surfaces; (3) to the length of time the rubbing surfaces have been in use; and (4) to the fact that the pull of the belt sometimes relieves and sometimes increases, as it were, the weight of the cone pulleys, &c.

It was decided to determine the value of each of these points upon one machine. A large lathe with 24in. centres, in the works of the Chemin de Fer de l'Ouest, was selected for the experiments. The power absorbed was measured (1) when running light at various speeds; and (2) when doing work measured by a Prony brake. The total work supplied by the shop shafting was measured in each case by a transmission dynamometer. This dynamometer consisted of two pulleys placed side by side, joined by springs, and fitted with recording indicator gear to show the compression in the springs. It also registered the speed of the belt. It was carefully calibrated, and it was found that a pull of 1·666 kilo. moved the recording pencil one millimetre. The speed (v) of the transmission belt being approximately constant, each millimetre represented per second work equal to $1{\cdot}666\,v$ done by the belt. With the lathe running light, but revolving a heavy face plate, the following figures were obtained:—

Revolutions of face-plate per minute ..	18	33	55	90
Mean ordinates, millimetres	6	12	22	40
Kilogram-metres per second	17·49	34·98	64·13	116·60
Foot-pounds per second	126·5	246	464·4	840

From which it can be deduced that the amount of power absorbed in the machine increases as the speed is increased. But as friction is independent of speed its increase must be due to the greater pull on the belt at higher speeds.

As already stated, a Prony brake was employed to find out the amount of work absorbed when the machine was doing work. The brake wheel was fitted on a shaft driven by the lathe. From these experiments, when the lathe was making eighteen revolutions per minute, the following figures were found:—

Work absorbed by brake. Kilogrammes.	Work registered by dynamometer. Kilogrammes.
18·85	39·35
37·69	61·21
56·54	83·62
75·38	104·94

Thus subtracting the work done from that supplied we find in the first case a difference of 20·5 kilogrammes (148 foot-pounds) spent in friction. But it has been seen already that at this speed, eighteen revolutions, the machine requires 17·49 kilogrammes. The increase of friction due to doing work is, then, $20{\cdot}5 - 17{\cdot}49 = 3{\cdot}01$ for useful work of 18·85 kilogrammes, or, approximately, 16 per cent. It is also found on plotting the figures that the increase of friction is proportional to the useful work. The coefficient is, approximately, 16 per cent., but it varies with the lubrication and if the load on the brasses is excessive. Furthermore, it is not the same for all machines, and it is impossible to assign to any machine its proper coefficient, because (1) its efficiency is a function of two quantities, one the resistance running light, and the other the amount of useful work; (2) the first of these two conditions is dependent upon the lubrication. As, therefore, little satisfaction was to be got from such trials, it was decided to measure the work done when a tool was cutting, by finding the pressure at the tool, and multiplying it by the distance passed through in a known time. The proportion that this useful work bore to the work supplied, as shown by the transmission dynamometer, would give the efficiency of the machine. For this purpose a special apparatus called a "*toc dynamometrique*" was devised; it is illustrated by the accompanying figures. Here B represents the shaft of mild steel to be turned. Its end is reduced, and on it is fitted a sliding collar b. There is also attached to it the lever A which is pulled round by the face-plate through the medium of a compressed spring C. A system of bell-crank levers slides the collar b, and moves the indicator arm a.

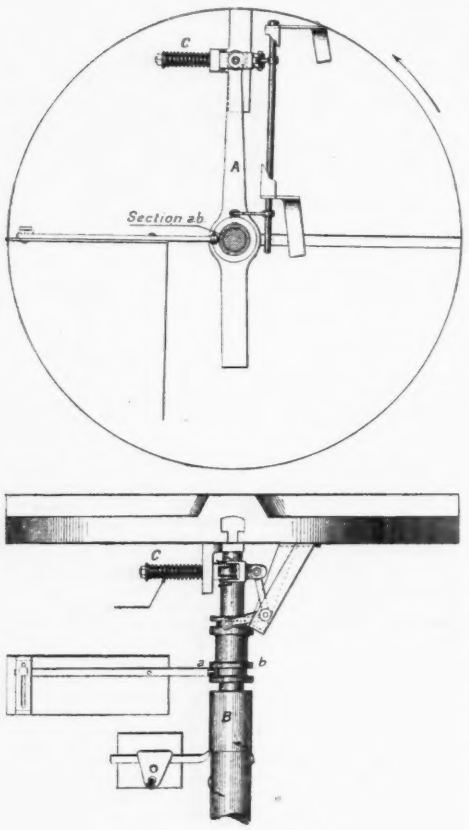
This "toc" was also used to find what pressure of the tool against the metal was required to start a cut. The resistance to penetration of the tool depends upon its sharpness, upon the quality of the tool, and upon the amount of surface in contact. To find the pressure endways of the shaft lead crushers 12 mm. diameter by 10 mm. thick were let into a recess at the end of the shaft behind the centre. The lead crusher was supported centrally in the recess by a needle point in the crushing work. The deformation of the crusher indicated the sideways thrust on the tool—that is, the feed—whilst the "toc" showed the force with which it was pressed into the work.

The calibration of the toc having been made, a set of experiments was carried out. The shaft was first reduced to a true cylinder, 102 mm. (about 4in.) diameter by an initial cut. A trial cut 5 mm. deep was then taken, and the pressure at the tool was found to vary between 270 and 337·5 kilos.—say, 594 lb. and 743 lb. The mean pressure was 315 kilos. (693 lb.). The variations in pressure were attributable to two principal causes, the heterogeneity of the metals and the breaking of the turnings. The metal used left much to be desired in the matter of homogeneity, and the indications varied suddenly when a certain part of the circumference of the shaft was being cut. Also whenever a shaving broke, the indicator fell suddenly. This is explained by the fact that whilst the turning is sound the tool is both cutting the metal and bending it; but when it breaks, the effort needed for bending is momentarily relieved, and the pressure falls.

The work done by the tool was calculated as follows:—The feed was 102 mm. in 15 min., the speed seventeen revolutions per minute; in 15 min. the plate made 255 revolutions; the tool advanced 102 mm. in the same time. For one revolution the advancement of feed was $\frac{102}{255}$, or 0·4 mm. The weight of metal removed per hour was 4·849 kilos. The total number of revolutions per hour was $17 \times 60 = 1020$. The circumference turned was $102 \times \pi = 0{\cdot}32$ m. The total length cut by the tool was then $1020 \times 0{\cdot}32 = 326{\cdot}4$ m. per

hour. The pressure on the tool being approximately 315 kilos. on the average, the useful work—that is to say, the work necessary for the effect produced—was 326·40 m. × 315 kilos. = 102,816 kilogram-metres (say, 743,500 foot-pounds) for 4·849 kilos. (10·67 lb.) of turnings. To produce one kilo. of turning, 21,200 kilogram-metres (say, 153,300 foot-pounds) would then be required. When the tool was freshly sharpened, the pressure on it descended from 315 to 270 kilos., as has already been seen. Under these special circumstances, which are necessarily of short duration, the expenditure of useful work to produce one kilo. of turnings was $\frac{21,200 \times 270}{315} = 18,170$ kilogram-metres, or 131,400 foot-pounds. In experiments made some months previously, a similar calculation, but for iron, worked out 23,900 kilogram-metres per kilo. of turnings, or about 78,636 foot-pounds per pound of turnings.

It is, of course, evident that the amount of work necessary to produce one kilogramme of turnings, independently of the work absorbed by the machine, varies with the quality of the metal turned, the thickness of the turning, the form of the tool, the cutting angle, the degree of sharpness, &c. Table I. shows the results obtained with three different machines. In these three types the effort is continuous, whilst in planing, slotting, and shaping machines, &c., the effort being alternating, there is a further supplementary expenditure of work to return the tool to its initial position. But the investigation being on the work done by machines, the choice of what type of tool is best is not considered. The most effective production does not imply necessarily an obligation to use the type of tool which gives it in preference to another; a lathe cannot evidently replace a milling machine, for the sole reason that it absorbs less power in producing a certain amount of turnings. In a lathe the



DYNAMOMETRIC TOC

work is carried on points, and the increase of work occasioned by the friction on the fixed centre caused by the pressure of the tool is relatively feeble; in a milling machine, the friction taking place at the periphery of the driving spindle, the leverage is much greater, and in consequence, the work supplementary to the actual cutting is far higher. Again, in a drilling machine the friction of the drill against the sides of the hole it has cut, and the effort required to remove the shavings, add to the work done by the machine. All these factors, variable through large limits, make it impossible to treat all tools as the lathe could be treated. It was necessary, therefore, to limit the trials to observing the work, when light, in order to deduct it from the power required when usefully employed. All the supplementary work and the parasitic phenomena—*phénomènes parasitaires*—were thus included.

Further experiments were carried out on reciprocating machines. A preliminary test was made on a shaping machine. A lead crusher was fixed behind the tool box, and it was found that the maximum cutting pressure amounted to 210 kilos. (462 lb.) per square millimetre of the cross section of the cut, or over 133 tons per square inch. On the lathe the mean pressure was found to be 157·50 kilos. per square inch, area of cut nearly 100 tons per square inch, and it is considered that this compared with the maximum on the shaping machine—the movements of the indicator in the first case favouring the view—indicates that the force required for cutting is nearly the same when turning or planing.

Experiments were conducted with two planing machines of practically the same dimensions and the same power, but in one the return was made at twice the cutting speed, in the other at three times. In this type of machine, the work not being under the control of a fly-wheel, the load on the belt varies considerably, above all at the extremities of the stroke when the table has to be stopped and reversed; there is thus a great expenditure of work without any useful effect. The rapid speed of return is also a further cause of expenditure, for an analogous reason to that already indicated in the speed tests of the lathe.

In the planing machine with the return at twice the cutting speed, the work on the out-stroke expended was 31·62 kilos. per second; for the return the work should be double, but it was found to amount to 73·78 kilos. instead of 63·24 kilos. There was thus a supplementary expenditure of 10·54 kilos. In the other planing machine the work per second on the out-stroke was 27·9 kilos., on the return 130·2 kilos., equal to a supplementary expenditure of 46·5 kilos. The weight of the piece operated on was insignificant as compared to the weight of the table.*

It was found that the drag of the tool along the work in the return stroke amounted to about 7 per cent. of the whole work expended.

A slotting machine and a grindstone were also tested. The latter was 2·085 m. in diameter, by 305 mm. thick. Its weight was 2443 kilos. Its total weight with shaft, washers, &c., amounted to 3176 kilos. It made 135 revolutions per minute, giving a circumferential velocity of 14·73 m. per second. Running light the mean load on the belt was 20 kilos. The horse-power required to keep the stone rotating was 1·5. The trials were carried out on two pieces of steel, one hard, the other mild; 250 mm. by 30 mm. in cross section. One of these pieces was fixed in the tool box of a lathe slide rest fixed at a convenient height. The screw for traversing the tool box was removed and replaced by a plain rod, which was pressed in by a weighted lever, giving a mechanical advantage of 5 to 1, and an actual pressure of 200 kilos. against the stone.

The hard steel caused a pull of 215 kilos. on the belt, and took 16-horse power. The soft steel produced a tension of 310 kilos. in the belt, giving at the speed 23·15-horse power. This surprising difference is accounted for by the work done. In twenty minutes the hard steel only lost 10 grammes, whilst the mild steel in the same time lost 1·840 kilos. Grinding, it appears, may then be divided into two distinct efforts—one, a braking effort which, in this case, amounted to two-thirds of the whole, the other the useful work done in wearing away metal. In this trial, 1,136,300 kilos. were expended to remove 1 kilo. of soft steel, or about fifty times as much as was required on the lathe.

The pressure of 200 kilos. upon a surface 250 by 30, or 75 square centimetres, corresponds to a pressure of 2·66 kilos. per square centimetre ground. It appeared to be sufficient for the mild steel, but for the hard steel it had to be augmented to get a sensible effect. Actually a workman grinding the same piece of steel removed 850 grammes in twenty minutes, or 2·55 kilos. per hour, in working with a pressure which was actually less, but which was increased by moving the steel so that a small portion only was acted on at a time.

* It is not clear if the machine was idle or was working when these experiments were made. Presumably it was working.—Ed. The E.

TRIALS OF MACHINE TOOLS.

TABLE I.—*Lathes.*

	Pull on belt.	Speed of belt.	Work in kgm. per second.	Speed at tool per second.	Weight of turnings per hour.	Net work to produce 1 kg. of turnings.	Net work to produce 1 lb of cuttings.
		m.	kgms.	mm.	kg.	kgms.	Foot-pounds
1. Tire lathe—Empty	13·95	3·60	50·22	—	—	—	—
Working—with 1 tool	21·7	3·60	78·12	67·5	3 000	33,500	110,1 0
,, with 2 tools	31	3·60	111·60	67·5	6·000	40,100	134,400
3. Locomotive wheel lathe—Empty	18·6	2·10	39·06	—	—	—	—
Working—with 1 tool	43·4	2·10	91·14	50 0	3·600	62,000	208,100
,, with 2 tools	71·3	2·10	149·73	50·0	7·200	58,500	192,300
5. Carriage wheel lathe—Empty	15·5	2·65	41·07	—	—	—	—
Working—with 1 tool	62	2·65	164·30	60·0	19·200	22,700	74,610
,, with 2 tools	108·5	2·65	287·52	60·0	39·000	22,700	74,610
6. Carriage wheel lathe—Empty	13·95	4·60	64·17	—	—	—	—
Working—with 1 tool	31	4·60	142·60	55·0	6·800	41,500	136,400
,, with 2 tools	65·1	4·60	299·46	55·0	14·250	39,600	130,100
7. Locomotive wheel lathe—Empty	6·2	4·60	28·52	—	—	—	—
Working—with 1 tool	27·9	4·60	128·34	34·3	12·800	28,100	92 370
,, with 2 tools	49·6	4·60	228·16	34·3	28 800	33,000	108,800
8. Three face plate lathe (à 3 plateaux)—Empty	13·95	1·70	23·70	—	—	—	—
Working—with 1 tool	21·7	1·70	36·89	48·0	1 900	25,000	82.180
,, with 2 tools	51·15	1·70	86·95	45·0	8 200	28,500	93 670
,, with 3 tools	80·6	1·70	137·02	45·0	14·500	28,509	93,670
11. Parallel lathe—Empty	12·4	2·85	35·34	—	—	—	—
Working	38·75	2·85	110·43	147·25	9·000	29,000	15,330
12. Parallel lathe—Empty	20·4	2·60	53·04	—	—	—	—
Working	44·2	2·60	114·92	182 0	9 260	24,200	79,380
15. Lathe—Empty	18·6	1·70	31·62	—	—	—	—
Working	38·75	1·70	65·87	140·0	4·000	26,800	88 000
24. Parallel lathe—Empty	1·66	2 0	3·33	—	—	—	—
Working	8·35	2·0	16·65	88·0	2·153	24,500	74,470
24 *bis.* Parallel lathe—Empty	1·66	2·0	3·33	—	—	—	—
Working	13·35	2·0	26·64	79·0	3·246	25,000	82,110

TABLE II.—*Milling Machines.*

	Tension in the belt.	Speed of belt.	Work in kgms. per second.	Diameter of heli-coidal cutter.	Peri-pheral speed of tool.	Feed per second.	Depth of cut.	Weight of shavings per hour.	Net work in kgm.'s per kilo. of shav-ings.	Net work in foot-pounds per lb. of shavings.
		m.	kgm.	mm.	mm.	mm.	mm.	kg.	kgm.	
13. Milling machine—Empty	68·2	3·25	221·65	47	320	0·8	—	—	—	—
Working	105·4	3·25	342·55	47	320	0·8	2·3	6 561	66,700	218,600
Working	139·5	3·25	453·375	47	320	0·8	4 8	13·700	61,000	200,500
17. Milling machine—Empty	30·6	3·60	110·16	42	400	1·705	—	—	—	—
Working	57·8	3 60	208·08	42	400	1·705	2·0	8·226	42,800	140,700
19. Milling machine—Empty	10·2	3·90	40·0	32	268	0·8	—	—	—	—
Working	32·3	3·90	126·0	32	268	0·8	2·5	5·550	56,300	185,000

TABLE III.—*Drilling Machines.*

	Tension in the belt.	Speed of belt.	Work in kgms per s cond.	Diameter of twist drill.	Peri-pheral speed of tool.	Feed of drill per second.	Weight of shavings per hour.	Net work in kgm.'s per kilo. of shav-ings.	Net work in foot-pounds per lb of shavings.
		m.	kgm.	mm.	mm.	mm.	kg.	kgm.	
14. Lathe (drilling crank shaft of locomotiv.)—Empty	5·5	3·50	29·75	55	43·2	0·035	2·35	54,000	179 700
Working	18·7	3·50	65·45						
16. Double drilling machine—Empty	13·95	2·60	36·27	20	167·5	0·255	2·25	51,000	167,600
Working	26·35	2·60	68·51						
16 *bis.* Ditto. —Empty	17·0	2·10	35·70	30	267·0	0·333	6·80	54,500	179,100
Working	64 6	2·10	135·66						
18. Drill—Empty	3·1	3·25	10·0	25	210 0	0·351	4·70	35,000	115,000
Working	17·05	3·25	55·0						
21. Radial drill—Empty	3·33	3·75	12·50	23	—	0·333	4·28	52 500	172,500
Working	20·11	3·75	75·0					Copper.	
22. Ditto. —Empty	23 8	2·70	64·26	51	226·0	0·165	9·54	41,500	136,400
Working	64·6	2·70	174·42						
23. Ditto. —Empty	1·55	3·70	5 75	Couronne.	208·0	0·033	2·33	62,000	203,800
Working	12·4	3·70	45·80	51—26·5					

TABLE IV.—*Planing, Slotting, and Shaping Machines.*

	Tension in the belt.	Speed of belt per second.	Work in kgms. per second.	Speed of tool.	Depth of cut.	Weight of shavings per hour.	Net work in kgm.'s per kilo. of shavings.	Net work in foot-pounds per lb. of shavings.
Planing machines.		m.	kgm.	mm.	mm.	kg.	kgm.	
9. Planing machine—Empty—Cutting	9·3	3·0	27·90	73·3	—	—	—	—
Returning	43·4	3·0	130·20	2 0·0	—	—	—	—
Working—Cutting	27·9	3·0	83·70	73·3	3·6	4·320	46,100	152,100
Returning	46·5	3·0	139·50	220·0	—	—	—	—
10. Planing machine—Empty—Cutting	9·3	3·40	31·62	51·0	—	—	—	—
Returning	21·7	3·40	73·78	102·0	—	—	—	—
Working—Cutting	26·35	3·40	89·59	51·0	6·0	6·320	33 000	108 000
Returning	23·25	3·40	79·05	102·0	—	—	—	—
Slotting machine.				Mean.				
27. Slotting machine—Empty	13·95	1·85	25·80	100·0	—			
Working	37·2	1·85	68·80	100·0	8·0	2·700	57,300	188,400
Shaping machine.								
Shaping machine—Empty	6·66	2·50	16·65	105·0	—			
Working	20·0	2·50	49·95	105·0	3·5	3·400	35,000	115,050

UTILISATION OF HIGH-FURNACE GASES FOR POWER IN GAS ENGINES.

By Bryan Donkin, M. Inst. C.E.

No. I.

One of the most striking developments of modern engineering skill is the application of the gases generated in high furnaces to produce power. Gas engines, seldom heard of in the first half of the century, and to improve which so many inventors laboured during the following twenty-five years, did not become available for practical purposes to any extent till the Otto four-cycle engine appeared in 1876. Since then there have been three stages in the evolution of internal combustion motors, according to the nature of the explosive agent employed to drive them. At first lighting gas was used, and oil in a few instances. About ten years after Otto's great invention it was found by no means necessary to burn gas of high illuminating value to produce power. The same result could, as proved by Dowson and others, be obtained with a much poorer gas made on a cheaper system, with but slight modifications in the ports and valves of the engine. Most large gas motors in England and abroad are now worked with this cheap or power gas. A third step in the development of these engines, and one which bids fair to rival the others in importance, has been made within the last few years. This is the surprising discovery, the true bearings of which are only now perceived, though they have been visible for years, that gases from high furnaces constitute an excellent source of power, if treated in the same way as lighting and power gas, by explosion and combustion in an engine cylinder. Furnaces for the production of pig iron form, in fact, ideal gas generators.

The bulk of these gases has till lately been, and is even now, often wasted. Twenty-five years ago they were got rid of by burning them at the top of the furnaces. With the present system part has been drawn off and used to heat the air blast, a larger proportion burnt under boilers to raise steam to drive the blowing engines delivering hot air to the furnaces; the remainder has been discharged to waste. As the value of the gases was not realised, no economy in this partial utilisation of them was attempted, and their heating value being low they are burnt to much disadvantage under boilers. It is estimated that a money saving of nearly 50 per cent. can be effected if, instead of thus using them, the gases are conveyed direct to a gas engine, and the power furnished by their combustion and expansion employed to supply blast. With full deductions for leakage in the pipes, and for the necessary purposes of the furnace, viz., for heating the air blast and working the blowing engines, it has been calculated that at least 60 per cent. in volume of the gases would thus remain over, to be utilised as power. To turn this great surplus store of energy to account is the problem now confronting engineers, chemists, and metallurgists, and which is at last in a fair way to be solved.

The practical difficulties of burning high furnace gases in the cylinders of engines have already been more or less overcome. Their low heating value, about one-fifth that of lighting gas, is counteracted by the much higher compression to which they are raised by the motor piston, making them ignite more readily. The variations in their pressure and composition are not so great as was at first supposed, and trouble on this score is obviated by storing them in a gasholder. The main difficulty anticipated was from the quantity of metallic dust, light or heavy, they carry off on leaving the furnaces. This seemed, at first, an insuperable obstacle to their use for power; but it has been met in various ways. The gases are purified more or less, by the wet or dry process, the method and degree varying according to the furnaces from which they are drawn; the small quantity of dust which cannot be got rid of is blown out of the cylinder with the exhaust gases. Some engines, especially on the Continent, have been working long enough with these gases to show that they are perfectly adapted for use in internal combustion motors.

The real difficulty, which will soon, we may hope, cease to be one, is to adapt gas engines, hitherto made only in relatively small sizes, to the much larger powers now required. Engine-builders on the Continent have risen to the occasion, and already supply them of 1000 to 1500-horse power; our English makers have not, perhaps, been quite so ready to take advantage of this new departure in gas engine work. In view of the enormous pig iron trade of Great Britain, it is much to be desired that they will prove themselves equal to the somewhat sudden demand for higher power engines, and the enterprise of German, French, and Belgian firms may point a salutary lesson. There appears to be no sufficient reason why gas engines should not be made of 1000 as easily as of 100-horse power, provided the number of cylinders is increased. The single-cylinder type with one crank is seldom desirable for high powers, though one important continental firm still adheres to it.

The idea of utilising high-furnace gases to drive gas motors seems to have originated almost simultaneously in several countries. During 1895 experimental engines were started successively at the Glasgow Ironworks at Wishaw by Mr. Thwaite, at Seraing in Belgium by the Société Cockerill, and at the Hörde Ironworks in Westphalia. It was at this latter place that the Oechelhaueser, an original and interesting engine, made its appearance. It is a two-cycle motor, with two pistons working in opposite directions in one cylinder, and is similar in type and arrangement to the first Atkinson, known as the "Differential." Two-cycle engines have not hitherto found much favour, because of the complication involved in a second cylinder, as compared with the simplicity of construction of the ordinary single-cylinder four-cycle type. The difference between a two-cycle and a four-cycle engine is that in the former the pump for compression and delivery of the charge is separated from the motor or working cylinder; in the four-cycle type the two are combined in one cylinder. The Oechelhaueser engine is said to yield four times as much work as the four-cycle for the same piston diameter and the same speed, because each of the two pistons works at equal speed. In the near future this engine may possibly have a considerable development. In the opinion of so eminent an expert as Professor Meyer, it is especially adapted for high furnace gases, with which alone it has hitherto been driven.

The engine has usually one long motor cylinder with two pistons moving in opposite directions, and an auxiliary double-acting air pump. It has no valve gear, the admission and exhaust ports being uncovered and shut off by the pistons; and, as in most engines having motor and pump cylinders, a scavenging charge of air is admitted to drive out the products of former combustion. All these advantages are, however, in some measure counterbalanced by the complication of motor and pump cylinders.

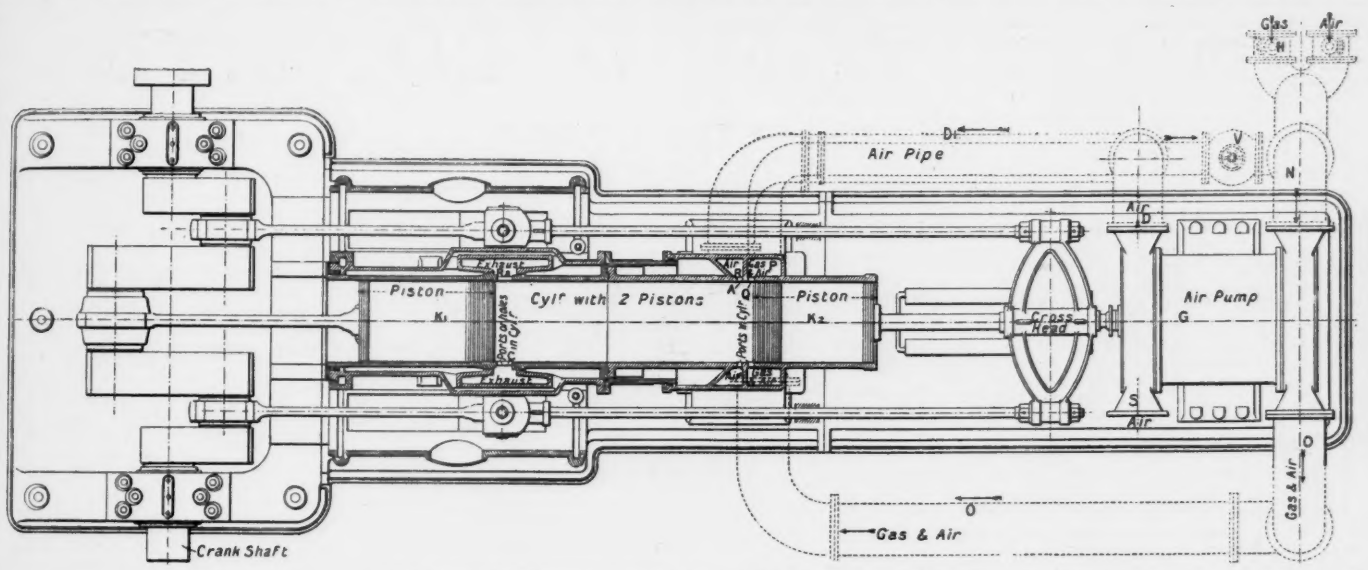


Fig. 1—600-HORSE POWER OECHELHAUESER TWO CYCLE GAS ENGINE

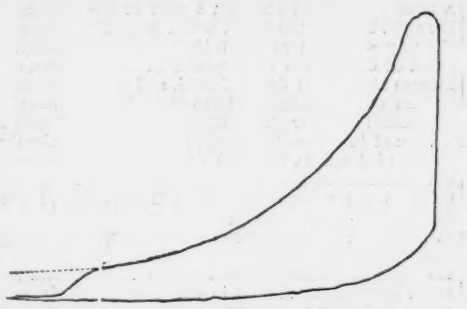


Fig. 2—Indicator diagram from 600-horse power Oechelhaueser two cycle gas engine at Horde.

Fig. 1 shows a plan of the engine in which G is the double-acting air pump, and K_1 and K_2 the two pistons both working in the motor cylinder on to the same crank shaft, through three cranks 180 deg. apart. The back cross-head works the air pump. When the two motor pistons, which move in opposite directions, are at the inner dead-point of the centre crank, and thus nearly touching, the space between them contains a compressed combustible mixture of gas and air at a pressure of eight to ten atmospheres above atmospheric pressure. The mixture is then fired electrically, and the pressure increases in proportion to the heating value of the charge; the pistons are driven out, and both do work upon the crank shaft. During these two strokes, compression and motor, the piston working in the air-pump cylinder G draws in fresh air through the opening S, and the front part of this piston compresses it at a slight pressure above atmosphere through D and the air chamber R into the compression space. Meanwhile the back part of the air pump piston having drawn in a mixture of gas and air through N, compresses it through O into the mixing space P, where it is at the same pressure as the air in R. At a given distance from the outer dead point of the centre crank, the piston K_1 begins to uncover the exhaust ports C. The products of combustion in the working cylinder, at a pressure of about two and a-half atmospheres, escape through the ports and passages leading to the exhaust. At this moment piston K_2 begins to uncover the air ports A, and fresh, cool air streams into the motor cylinder, and sweeps out the products of combustion still left in it, forming an efficient scavenger stroke. Finally the piston K_2 uncovers the port Q, and the mixture of gas and air, previously compressed to about one-third of an atmosphere, enters the motor cylinder. The pistons now begin the return stroke, until they again almost come together, compress the mixture between them, and the cycle recommences.

To prevent waste of gas by the escape of the fresh charge through the open exhaust ports, the dimensions of the working cylinder are said to be so proportioned that the utmost quantity of mixture entering per revolution, when the engine is working at maximum speed, only occupies about 70 per cent. of the total cylinder volume. When the speed is regulated by the governor within narrow limits, the relative proportions of the charge of gas and air are varied; if wider limits of speed are allowable, the amount of the charge introduced per stroke is varied. The governor is supposed to act simultaneously upon the mixing valve cock H and the return slide valve V in the passage L, which, when opened, allows part of the compressed mixture to pass out of the passage O into the suction pipe N. Thus, to reduce the speed, part of the charge is transferred to the other side of the pump, instead of passing to the motor cylinder.

From this description of this two-cycle engine it will be seen that in the single motor cylinder one working stroke per revolution is obtained with two pistons. Admission and exhaust are effected in one stroke or half a revolution, instead of each requiring a separate stroke. As a result, the dimensions of the cylinder are smaller, the 500 brake horse-power engine having a diameter of 650 mm. = 25·6in., and the 1000 brake horse-power of 935 mm. = 36·8in., with a corresponding reduction in weight. The cooling water jacket appears to work well. Large cylinder dimensions, as is well known, diminish the action of the jacket, because the volume of the charge, the temperature of which has to be reduced, varies according to the square of the diameter, while the cooling jacket surfaces vary according to the diameter only. The scavenger charge of fresh air, which, at Hörde, is taken from the air pipe of the blowing engine, has also a good effect upon the cylinder, and helps to cool all the internal surfaces. If the temperatures are too high, premature ignitions occur, it is difficult to lubricate the engine, and this causes the internal parts to suffer. In the Oechelhaueser these evils of over heating are said to be avoided. It has the further advantage of practically dispensing with valve gear, the pistons uncovering the ports in the cylinder. Except a small valve, which works only at starting and is then thrown out of play, there is no valve driven by gearing in the engine. Nor are there sharp angles in the cylinder where dust can settle, and this is an important point in an engine driven with high furnace gases. Even if dust were present in large quantities, as is sometimes the case, it is carried through the cylinder smoothly and without difficulty by the scavenger charge of fresh air. The driving gear is relatively light, and is so arranged that the weights for the greater part balance each other. As there is only one motor cylinder for powers up to 1000-horse power, and this cylinder and the air pump are in the same axis, they are easily inspected and repaired.

The Oechelhaueser was one of the first engines of large size to work with high furnace gases. The authorities at

the Hörde Bergwerk Hüttenverein having tested the value of this new power agent on an experimental Otto engine, a 600-horse power Oechelhaueser motor, consisting of two single-cylinder engines, each developing 300-horse power, was made for them by the Berlin-Anhaltische Maschinenbau Gesellschaft, now the Deutsche-Kraft Gesellschaft. This large power plant was seen by the writer at work in the autumn of this year. Each engine has one long cylinder 480 mm. = 19in. diameter, and 800 mm. = 31·5in. stroke, with two pistons and three cranks, or an aggregate of two cylinders and four pistons, the dynamo being between them. Speed 135 revolutions per minute. One of the engines has been working for about a year, but no official tests have yet been made. Fig. 2 gives an indicator diagram. A 600-horse power engine is now being erected at Hörde, with space for two more. Several large single-cylinder engines of 1000-horse power are in hand; one of them will indicate 1000-horse power when going at 50 revolutions, and 1500-horse power if run at 80 revolutions per minute. This slow speed is adopted for the blowers, which are to be worked direct from the gas engines. Cylinder diameter 730 mm. = 28·7in. Stroke 1400 mm. = 4ft. 7in. A 1000-horse power Oechelhaueser engine, with two cylinders and four pistons, driven with high furnace gases, is now in course of erection at Fischershütte, near Hanover. The Deutsche-Kraft Gesellschaft build these engines single-cylinder of 300, 500, 750, and 1000-horse power.

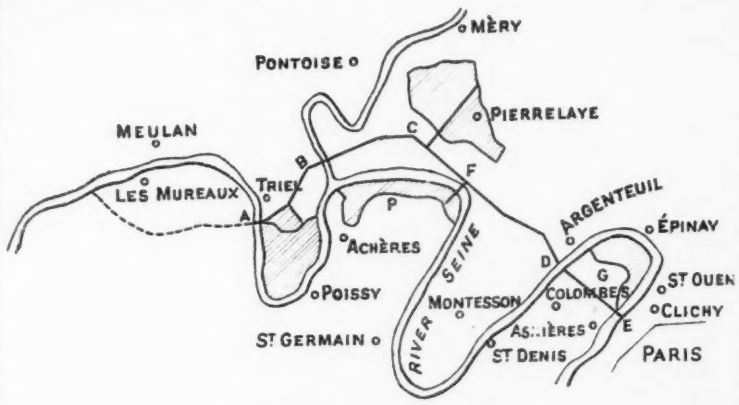
DIVERSION AND PURIFICATION OF THE SEWAGE OF PARIS.

The result of the extensive and highly important engineering works which have been carried on in Paris during the last five years, and devoted to sanitary, utilitarian, and agricultural advancement, will be looked for with much interest in even the immediate future. It is barely three months ago since the coping stone was placed upon the great undertaking which will for ever forbid the contents of the Parisian sewers to mingle again with the waters of the Seine. Descriptions and illustration of the chief engineering and constructive works connected with this vast national enterprise have at intervals appeared in our columns, to which we may probably briefly refer, but which will in no way interfere with our present object. It is our intention to lay before our readers a short, succinct, and connected account of the practical realisation of a scheme which marks a distinct area in the progress of sanitary science in France, and is endorsed with features possessing the strongest interest for, and deserving the attention and consideration of the engineer, the scientist, the chemist, and the agriculturist. Similarly to all great projects, the one before us was not ultimately sanctioned for execution until after many fierce battles had been fought over it. As with us, so it is in France. In both countries the principle of the utilisation of sewage by its application to land, has, on the one side, many staunch and powerful adherents, and on the other, numerous and hardy opponents.

About the year 1854 a very great improvement was introduced in the whole *réseau* of the sewers of the French metropolis. Previously to that date their contents were discharged into the Seine by a multitude of outfalls. The construction of a completely new system of sewers and collectors at that time, which are still in active operation, enabled the outfalls to be brought to Asnières and St. Denis, shown in the accompanying plan. This fresh débouchment was at a considerable distance in the down-stream direction of the river, and very materially ameliorated the sanitary condition of the capital. That this was a decidedly progressive step, and one beyond which we have not gone towards the solution of the problem, will be admitted, but at the same time it was only a half measure. The French authorities were so convinced of this that they instructed an engineer to visit England and a few other European countries, and investigate and report upon the methods adopted by them. In the year 1865 their emissary pronounced his firm conviction that the only real satisfactory solution of the question was in the application of sewage to the irrigation of land, and ten years later he introduced his project for the irrigation of the now well-known plans of Gennevilliers and of Méry. It was in this very year that our own southern outfall works were opened at Crossness, and subsequently followed by those on the north bank of the Thames at Abbey Mills—works which, similarly to those already completed in France, are of a palliative character, but in nowise partaking of the drastic remedy which alone can cure the evil. Before proceeding further, it will be well to explain the small map attached to the article. The river Seine will be at once known by its many windings, and the thick black line marked A, B, C, D, E, shows the course of the main sewer constructed to allow of the discharge of the sewage upon the different areas of land allotted for irrigation purposes, which are distinguished by hatched lines.

The first experiments with the application of sewage to land were conducted in 1868 at Clichy, and the result was considered so satisfactory that they were afterwards extended to the plains of Gennevilliers, with a development and success so marked that a Special Commission, appointed seven years ago, afterwards reported strongly in favour of the principle of irrigation. At the same time that the application of sewage to land was on its trial, the Chatelier process of the purification of sewage by means of alumina was allowed a full and free scope for experiments, but the results were inferior to those arrived at by the other method of treatment. The next step towards a further extension of the system of irrigation was the acquisition of some 2000 acres, which was formed into an agricultural park at Achères—marked P in the annexed map—and supplemented shortly afterwards by the addition of an adjoining 250 acres. By a law enacted in the year 1889, which limited the maximum quantity of sewage water to be applied to a given area of land to 3,528,000 gallons per acre per year, it became necessary to acquire more land and undertake the construction of new drainage and sewerage works. The first of these was the portion of the main sewer between Clichy and the Achères, which extends from the point F to that at E on the plan, and thus became the first link in the great national sanitary enterprise. This work, which may be briefly referred to, was commenced in 1892, and completed three years afterwards. Coming to a more recent date, it was the law promulgated in the year 1894, which practically clinched the whole undertaking and ensured its speedy and successful execution. There is no doubt that this important Act of legislation was mainly prompted by the serious outbreak of cholera which took place in Paris two years previously, and was probably correctly traced to the inefficient and defective condition of the metropolitan drains and sewers. Be that as it may, the fiat was issued that the *tout à l'égout* system was to be universally adopted in dealing with the sewage of the capital, and that the whole of it was to be utilised in irrigating the different tracts of land scheduled in our block plan. The law also authorised the city of Paris to borrow a sum of £4,700,000, of which amount £1,232,000 were to be expended in the acquisition of additional areas for the purposes of irrigation, to levy an annual tax to pay the interest upon the loan, and to provide a sinking fund for its ultimate redemption. Five years were allowed for the carrying out of the necessary works, which, as already mentioned, have been completed within the specified time. Another decree of a couple of years' later date sanctioned the execution of various extra works in the department of the Seine-et-Oise, for the prolongation of the main outfall sewer from Achères to Triel, and for the construction of branches to irrigate the newly-obtained lands at Méry-Pierrelaye and at Carrières-Triel. It is these last works, recently finished, which allowed the main drain at Asnières to be definitely blocked up, and all connection between the sewers of Paris and the Seine severed for the future.

The total length of the sewers of Paris is about 625 miles, which flow into four principal mains, distinguished as that of the North, of Asnières, and of Marceau and



THE NEW SEWERS OF PARIS

Clichy. The first three of these main sewers belong to the earlier examples constructed in 1854, of which the northern, by means of two branches, conveys the drainage north of the right bank of the river to the plains of Gennevilliers by simple gravitation. Formerly these waters were discharged into the Seine, in the vicinity of Saint Denis. The passage of the river is effected by means of four cast iron pipes, placed beneath the roadway of the bridge of Saint Ouen. At Asnières, the collector of that name receives the drainage of the low-lying districts on the right bank of the river, as well as a portion of that belonging to the left bank, which flows through the syphon of la Concorde. Formerly the outfall of this sewer was in the Seine near Clichy, on the down-stream side of the bridge of Asnières. The Marceau main drain discharges into that of Asnières, a little way above its mouth, a part of the drainage of the right bank of the Seine, which is carried across the river by a syphon at the bridge of Alma. Lastly, the sewer of Clichy, the most recent in construction, commences at la Place de la Trinité, and after receiving a portion of the drainage of the right bank of the river, terminates at the works at Clichy, and joins off with the syphon of la Concorde. Thus, the contents of the three sewers of Asnières, Marceau, and Clichy, all empty into the installations at the last-named place, and part of them are pumped thence to Gennevilliers, through pipes laid underneath the footways of the bridge at Clichy. The remainder of the drainage is pumped into a syphon passing under the Seine, which constitutes the practical commencement of the new general main sewer shown from A to E in the plan. A prolongation of the syphon is formed by a main sewer flowing freely, which establishes a connection with the installation at Colombes, where any surplus water from the irrigated land at Gennevilliers, marked with the letter G on the plan, is conveyed by an especial conduit, pumped into an aqueduct crossing the Seine, and finally discharged upon some rising ground in the neighbourhood of Argenteuil. Subsequently the main sewer resumes its course, negotiates the valley of the Oise, with the aid of a syphon, and terminates for the present at Triel, quite close to the Seine. At a future date the irrigation system may be extended across the river to the plains of Epone and of Les Mureaux.

The main sewers of the new outfall are divided into two classes—those which discharge their contents under the simple action of gravity, and those which are subjected to considerable pressure, which forces the water through them. Of the two, the former has many advantages over its fellow. It costs less, since it is not necessary to give it the same degree of thickness. Owing to the continual presence of air, the development of bacteria is checked, and under certain conditions it can act as a temporary reservoir. At Argenteuil the location of the main sewer is at a height sufficient to cause the contents to flow by gravitation to the district of Mantes, at an elevation of 40ft. above that of the Seine at the same point, and thus reduce to a minimum the number and length of the more expensive class of drains. Starting from the installation at Clichy, the total length of the new outfall sewer is 17½ miles, and its maximum discharge is equal to double that of the sewers draining into it. Its internal section is circular, the diameter necessarily varying according to local conditions. For the gravitation sewers, the diameter has the constant dimension of 9ft. 11in., and the water can rise in them to a height of three quarters of the diameter. An exception to this general rule occurs on the tableland of Conflans, where the typical general single section will be replaced by a couple of smaller ones, each 6ft. 7in. in diameter, of which only one is laid at present, as it suffices for all practical requirements. In the second class of sewers the section varies considerably, that, for instance, of the syphon at Clichy being single, with a diameter of 7ft. 7in. At the aqueduct of Argenteuil the section is double, each having a diameter of 6ft., as far as the highest point, and increasing afterwards to 6½ft. at the junction with the syphons of Chennevières and of the Oise. The sewers under pressure at Argenteuil, are in a thickly populated neighbourhood, and to place them beyond the reach of wilful and accidental damage, they are laid in an elliptically-shaped tunnel 17ft. in span and 11ft. in height. A reference to the map will point out that there are several branches running from the main outfall to the various irrigation plots, such as that at F, supplying the agricultural parts of Achères. There are other branches at Méry and Pierrelaye which call for no particular notice.* The total length of gravitation sewers built in cutting, some of which are 10ft., others 6ft. 6in. in diameter, is 6½ miles, and those in tunnels surpass these figures by about an extra quarter of a mile. Irrigation schemes have been by no means completely satisfactory in this country, and there is some reason to fear that they will not be more successful in France.

When the French sanitary engineers set about the work of purifying the Seine, and created farms in the neighbourhood of Paris for depositing the sewage, they supposed that they had solved what at one time appeared to be a very awkward problem. The principle they adopted was practically the same as that employed in and around Berlin, and to a certain extent the conditions of the two cities are about the same, so that what would prove successful in the German capital would be likely to give equally satisfactory results in Paris. At first the sewage farms met with considerable opposition from the local populations, who brought actions for damages against the municipal council, but so far this body has been able to settle their disputes without being obliged to pay too much of the ratepayers' money in the shape of indemnities to the suburban inhabitants. The success of the Gennevilliers farm did much to stifle opposition and prepare the way for laying out farms elsewhere. Gennevilliers has certainly not seen its value enhanced as a residential locality, but, at the same time, it is generally recognised that, by fertilising the district, the sewage has converted what was once a comparatively barren country into prolific market gardens. The farm at Achères has been laid out upon a larger and more improved plan. The vast plain which receives the sewage is entirely given up to cultivation, and the municipal council seeks to impress upon the public the value of the system by placing facilities in their way to visit the "park," where they are able to judge for themselves of the complete absence of smell, and even to taste the pure water that flows from the ground into the Seine. It remains to be seen, however, whether these farms are capable of absorbing some thousands of cubic feet of sewage water every day for a considerable length of time. Whether or not the farms are capable of being soaked indefinitely, it cannot be denied that they are having at least a temporary success, but this is more than can be said of the new farm which was inaugurated a few months ago at Pierrelaye. The pumps were started with great ceremony in the presence of the Minister of Public Works, and in the speeches that followed great stress was laid upon the fact that Pierrelaye would become one of the richest agricultural districts in the neighbourhood of Paris. The results, however, have proved to be disastrous, for the sewage has flowed off the farms on to adjoining properties, where it has invaded the cellars and contaminated the wells to such an extent that the water is unfit for drinking. This state of things is so bad that the municipal council has been obliged to send round water-carts, and meanwhile there is great fear lest this inundation of sewage should breed typhoid fever. The municipal engineers say that they are not to blame, as they urge that the inundation is merely temporary, and is caused by the rising of the underground water-level following upon the soaking up of so much sewage, but they believe that the water

* We are indebted for some of our information to our valuable contemporary *La Revue Technique*.

will soon again fall to its normal level, when there is not likely to be any recurrence of the inundation. This explanation appears to be a very lame one, since the engineers evidently allude to the water which exists under the Paris basin. This layer can hardly extend so far as Pierrelaye, which is on a higher level, and lies, in fact, between the heights of Montmorency and the Seine at Pontoise. It appears that the farm lies on strata of rock and clay, and the sewage, after passing through the alluvial deposit, flows off the impervious rock and clay on to the adjoining territories. If this be found to be the case there is obviously no remedy but to suppress the farm altogether. Meanwhile the municipal council has stopped sending any more sewage to Pierrelaye, pending an inquiry into the cause of the inundation. The result of this inquiry will be interesting, as showing for the hundred and first time that sewage farms, after all, have their limitations.

SOME NOTES IN RUSSIA.

(From a Special Contributor.)

SOME CASUAL GLEANINGS CONCERNING PROSPECTS OF BRITISH TRADE.

EVERY Englishman in a foreign country, now-a-days that the "decline of British trade" shadow is upon us, feels called upon to pry into trade matters with which he may have no concern whatever. Whether the amateur thus engaged is able to arrive at any couclusions of value is, to put the best face upon it, probably a very open question; but, on the other hand, there are certain matters that he is more likely to stumble on, perhaps, than a more qualified man who goes over to make a serious investigation. It does not follow, of course; still there is always the possibility, since his interest is known to be of a vague and indefinite order. I am an amateur who came across certain sources not usually accessible—but I am still the amateur, and in such a light must these notes be read.

To begin with, let me take shipbuilding and closely allied matters, to which I have already, in previous numbers of THE ENGINEER, made passing references. It is a common belief in this country that the Russian navy is a child of the British one. This is only relatively true, because other foreigners were imported by Peter the Great and his immediate predecessors; and though the shipbuilders nearly all came from this country, yet their designs were always chastened—or spoilt, as the case might be—by Russian ideals. Peter the Great had very clear notions as to the particular types of ships that he wanted, and, such a mark did the great Tsar leave on Russia, that everything which applied in his time more or less applies still. Consequently, some attention to Peter the Great's shipbuilding programme is not merely interesting but necessary to any proper understanding of present-day conditions, because in Russia we have a country steadily, and without any deviation, following the lines laid down for it by Peter Veliky.

It was Peter the Great who laid down a prohibition against any cheeseparing economy in ship construction; and to this is due the present strong preference of the Russians for the best of everything. Some of the very best machinery ever turned out by British firms is in Russian warships, and when Russia applied abroad for machinery it was always to British firms with big reputations. A low contract price never attracted Russia, and never will. Indeed, Russia almost always pays more heavily than any nation on account of the extremely strict specifications that are made out; the slightest superficial flaw, though it would be accepted by any other nation, is refused by Russia, and contracts tend to high figures accordingly. Russia is *par excellence* the country in which what is termed the "cheap-and-nasty" has no market—and if anything approaching it is found in its war machines it is due to the peculative propensities of some minor official.

This demand for the best of everything, coupled with a widespread system of peculation and "squeeze," creates an extraordinary problem. However, this last is on the decrease, and twenty years hence, or less, will have totally disappeared in matters connected with shipbuilding. This may be looked for with absolute certainty.

The fact that nothing, or next to nothing, of the foreign-built portion of the new Russian programme of shipbuilding came to this country was attributed pretty generally to political causes, and less generally to our higher prices, or to our firms being less "squeezable." It had absolutely nothing to do with any of these things, but turned upon a much more prosaic axis—the Strike Clause.

Russia—more in following the ways of Peter the Great than for the thousand-and-one warlike reasons assigned—was, and is, in a very great hurry to receive the new ship, and in all the contracts an early date of delivery was fixed.

"In England," said to me a Russian in authority, "in England the firms promise nothing. They will not agree definitely to deliver by a certain date; they always say 'We will do so, if our workmen do not go on strike.' And the men always do go on strike! Why, you cannot even get your own ships delivered because of it, and if your new ships get delayed a year, when on earth should we get ours? So we have to go elsewhere and trust for the best."

Now this I know for a fact to be the view held by every single Russian in authority. The course of the great engineers' strike was followed by them with lively interest, and owing to their strong preference for British over other foreign machinery, followed with a good deal of genuine concern also. Certain parts of the new shipbuilding programme even hung back a bit, waiting. And here I may *en passant* remark, that in no single instance has anything gone wrong with machinery supplied by British firms to Russian warships; everywhere it was spoken of with admiration. But till we can convince the Russians that our firms are controlled by the masters and not by the vagaries of the men, this market will, I fear, remain closed. It is not a matter that the firms can mend—it is not a matter for them, but for the Government. Russia is already not singular in its views, and views of this sort will grow with terrible rapidity, given a few more strikes; and the rise and fall of great industries is not merely a matter for the shareholders and owners, it is a matter ultimately for the whole country, or, at any rate, for such portions of it as are compelled to pay poor rates. I care nothing for politics and know less; but when I was discussing these matters in Russia I could not help thinking that if only the political friends of the British workman possessed a tithe of the interest in him that they profess, they would see to it that going on strike in the middle of a job was heavily penalised.

To resume. The Russian statement continued that certain British firms not specified were offered practically whatever they might choose to ask if only they would waive the Strike Clause; but that in each case the firms concerned refused. I am not prepared to say whether this Russian idea is absolute fact or no; one or two firms to whom I put the question directly avoided an answer. But I am fully certain that it is the firm conviction of Russians.

To turn to other matters. In a previous article I have already mentioned that upon every machine working in the shops in Galernü Ostrov Dockyard I read the name of an English maker. In all the best private houses and hotels, sanitary appliances, and domestic utensils generally, usually bear the names of English makers. In the Imperial palaces there are English fireplaces; everywhere, and in all sorts of unexpected places, one encounters British-made goods. In an artists' colour-shop one will see more colours of English manufacture than in a similar shop in England; though upon everything there is a duty usually equal to its value.

In mills throughout Russia—and new mills of one sort and another are always being started—British machinery is in demand. But here, as in everything else, knowledge of Russia and of its ways is an absolute necessity for business. The ordinary travelling agent is useless in Russia, and if our trade in these things is falling into German hands, it is the fault of those who have tried the "new blood" principle. To be of any use, an agent must have been trained for Russia from his youth up. He must have fully grasped and understood the fact that time is not money in Russia, and that Russians will not alter their customs to suit his convenience. Russians take time to consider everything; they will "give an answer to-morrow" for weeks, they will "decide next year" on matters that would be settled off-hand elsewhere. The slightest attempt at hurrying their decision convinces them that an attempt is being made to cheat them. It is not enough for an agent to know this; he must be Russianised enough for it to be second nature to him, and the number of men capable of doing this well is limited. Germans are more easily able to do it than Englishmen; Scotchmen, however, are said to manage very well. Germans are always handicapped, and always will be, by the intense national feeling that Russia has against them, though no wise Teuton ever throws away a chance to try and transfer this animus to England. Both in this country and Russia, German influence is thrown heavily into the balance against any understanding between England and Russia. The political situation is merely a peg; it is a clever move in commercial war.

Belgium is the country that makes most headway in monopolising the best plums of Russian trade—and Belgium secures it in the name of France! A Frenchman and a Belgian are difficult to differentiate, where a foreigner is concerned; and the Belgians have cleverly used the Franco-Russian *entente* for their advantage. They understand how to play upon Russian patriotism, and Belgian firms have secured more than two or three fine contracts because their nation is "Russia's ally"! They themselves openly boast about it, and are far firmer believers in the Franco-Russian *entente* than either of the contracting parties. That alliance keeps going many Belgian engineering concerns. Conversely, whenever any Anglo-Russian relations are strained, our trade with Russia feels the difference.

As regards Russia itself, the country firmly believes that it is a manufacturing country and not an agricultural one. The Government believe it, and do all they can to foster it. Statistics may not bear it out—but that is a case of "so much the worse for statistics." The Government—not merely the people—believe that they are on the eve of supplying not only all their own wants in every species of industry, but also of exporting everything everywhere.

They are actually nothing of the sort, nor is there any immediate prospect of their being so. They are racially unfitted, and it is a case of chalk and cheese. The "stand-by" men of foreign nationality—Scotch in seven cases out of ten—are in the back ground everywhere. However, as I have said, Russians believe in this theory that they can become a manufacturing nation, and are anxious to attract foreign capital. Foreigners may handle everything in Russia except one thing—petroleum. All the shareholders in petroleum concerns must be Russian subjects. They are; but it is English capital that works the great petroleum borings none the less.

Speaking generally, British capitalists are shy of financing Russian industries, and on the whole—unless they know very much where they are—they are wise in their shyness. Their reasons, however, are usually wrong; they have more or less a fear that the State might plunder them. This is unlikely. Where danger lies is, curiously enough, rather in the possibility—a distant one—of the Government growing more "constitutional." Local municipal authorities would be worse than the police already are, and the police have generally to be "squared" for something. The Imperial Government has a high reputation for liberality in its dealings with foreign firms, and is not likely to do anything to create difficulties for foreign capital, without which that development upon which its heart is fixed has no chance of fruition.

What the future is most likely to see is a species of alliance between British and Russian firms for mutual benefit. Some such connection exists between Messrs. Yarrow and a similar firm in Russia—at Ijora, I think. In most industries, particularly in that of locomotive construction, there is room for many such alliances to the mutual benefit of both parties, since, as before stated, it will be many years, if ever, before Russian firms are able to stand alone. And this is the particular kind of "invested foreign capital" that the Russian Government appear to be most anxious to bring about.

MANCHESTER SEWAGE.

THE report of the experts engaged to investigate the question of the treatment of the sewage of the city of Manchester has lately been published under the date of October 30th. On the 23rd May, 1898, the Rivers Committee of the City Council decided to obtain the advice of three eminent experts, those chosen being Mr. Baldwin Latham, Dr. Percy F. Frankland, and Mr. W. H. Perkin, junior. The present report is the outcome of the joint investigations of these three. It is a bulky document—no less than twenty-three diagrams and two photographs accompany it, while a number of tables are interspersed in the letterpress. We can do no more than deal in outline with some of the points which it discusses.

The methods of sewage treatment are essentially of three different types:—(1) "Disposal" without any purification by discharge into sea, tidal estuary, lakes, rivers, &c.; (2) "separation" of more or less impurity by precipitation, mechanical or chemical—the impurity so removed is little more than the solid matters in suspension, those in solution which lead to nuisance through subsequent putrefaction being hardly affected by such treatment; and (3) "destruction" of more or less impurity by resolution into simple and inoffensive materials. In the third mode only is there any purification proper, so that for the destruction of impurity, *i.e.*, for the real purification of sewage, there is only one practicable means available, namely, the employment of bacteria in some shape or form. In fact, all methods of sewage purification actually practised are bacterial methods, whether so named or not. At the existing sewage works at Davyhulme there are 165½ acres of land available for the purposes of sewage disposal. The present treatment is precipitation by means of milk of lime and protosulphate of iron. The effluent flows almost direct into the Ship Canal. The sludge is sent, by means of pneumatic ejectors, through two cast iron mains to two tanks below Barton locks, each tank holding 1000 tons of sludge. It flows from these tanks by gravitation into a sludge steamer, which deposits it at sea beyond the Mersey Bar. The inadequacy of this treatment depends on the fact that the effluent is not stable, and putrefaction sets up after it has been some time in the canal. Three methods of supplementing the present works have already been before the Committee. These are (1) the treatment of the effluent on land; (2) the culvert scheme; and (3) the bacterial scheme, as proposed by Sir H. Roscoe and modified by the present Rivers Committee. These three systems are discussed in the report. The land treatment would need, at the rate of an acre per 500 inhabitants, no less than 1300 acres, exclusive of roads, carriers, and the usual adjuncts of a sewage farm. It is pointed out that the initial cost would be immense, the land most difficult to obtain, and, even if obtainable, not suitable for the treatment of sewage. The culvert scheme proposes to take the sewage down to the Mersey at Randall's Sluices. The culvert itself would be 6½ft. in diameter, and have a fall of 1 in 2100. Its full discharging capacity would probably be about 67,000,000 gallons per day. This represents the rate at which sewage could be got away from Davyhulme. As it is by no means an uncommon thing, in times of rain, for the sewage to come to the works, for hours together, in twice and more than twice this volume, the culvert system plainly has its defects. The bacterial scheme of Sir H. Roscoe provides for the chemical treatment of the sewage as at present to be followed by bacteriological treatment of the tank effluent on specially-constructed beds of cinder or other suitable materials, an area of 37 acres being recommended. The scheme as modified entails the disposal by steamer of 190,000 tons of sludge annually as well as a yearly outlay of £5000 on chemicals. The investigators felt that some simpler and cheaper system might be discovered, and to this end they proceeded to carry out a searching experimental investigation with the object of discovering how bacteriological processes could best be applied to the Manchester sewage. They were satisfied that the solution of the problem lay in this direction, but there were some urgent matters which required elucidation. A few of these were:—(1) Whether the trade refuse in Manchester sewage seriously impaired the efficiency of the bacteriological treatment; (2) whether a portion, at any rate, of the sludge can be destroyed by bacterial agency; (3) whether the addition of chemicals to the sewage before bacteriological treatment can be done away with; and (4) whether the aërobic process—decomposition of organic matter by bacteria in the presence of air—or a combination of anaërobic, similar decomposition without air, and aërobic processes, is the more advantageous.

Bacteria beds and a septic tank installation were constructed at Davyhulme, and with these an extended series of experiments were carried out. "These," says the report, "have been continued up to the present time, and have served not only to elucidate the principles of successful bacterial treatment, but have also enabled us to formulate a definite scheme for dealing with the sewage of Manchester in its entirety, which we have no hesitation in recommending to your Committee for adoption." It would be tedious if we went right through the numberless experiments which were tried, but we may, at all events describe the lines on which the investigators worked. The bacteria beds used are five in number; they

were constructed with 6in. concrete sides and bottoms, rendered with cement mortar ½in. in thickness, the sides having a slope of 2 to 1. Four of the tanks are 33ft. 6in. square at the top, 17ft. 6in. square at the bottom, and 4ft. deep. The fifth tank is 12ft. square at the top, 3ft. square at the bottom, and 4ft. deep. These tanks were lettered A, B, C, D, and E. The filtering material is composed of clinkers laid to a depth of 3ft. With the exception of some rough material immediately surrounding the pipes the size of the clinkers is uniform throughout each bed, and is as follows:—In A the clinkers have passed a 3in. mesh and been rejected by 1in. mesh; B, passed by 1in. mesh, rejected by ½in. mesh; C, passed by ½in. mesh, rejected by ¼in. mesh; D and E, passed ¼in. mesh, rejected by ⅛in. mesh. The sewage reaches the beds by means of 6in. socketed drain pipes with cement joints. The troughs for distributing the sewage and filtrate upon the beds are of wood, laid upon the surface of the filtering medium, and are perforated near the bottom so as to give an even distribution over the bed. There is one main trough with six branches on each bed. The beds can be supplied with raw sewage from the main outfall sewer above the screening chamber and catchpits, as well as with settled sewage from the end of the sewage carrier, a portion of which has been formed into a small settling tank by the construction of a cross-wall. Settled sewage can also be taken from the large precipitating tank adjoining, which thus virtually becomes an open septic tank. After allowing for the slope of the sides, each of the beds A, B, C, and D, has an effective superficial area of about $\frac{1}{76}$, or more accurately ·0131, of an acre.

The septic tank used is 40ft. long, 12ft. wide, and 9ft. 2in. high, having an arched roof, and there are six filtering beds, the average area of each bed being 294 square feet. The medium depth of the filtering materials is 4ft., and it is composed as follows, from the bottom upwards:—1ft. of clinker, which was passed by a 3in. mesh, and rejected by 1in.; 2ft. 9in. of clinker passed by a ¾in. mesh, and rejected by a ⅛in. mesh; and 3in. of residue from the foregoing, which will pass through a ⅛in. mesh.

There are two Roscoe filters, each having an area of 25 square yards. They are 4ft. deep, and are filled to a depth of 3ft. with filtering material, in one case coke, in the other cinders, graded as follows, beginning with the bottom layer:—12in. of rough clinker; 9in. screened to pass 1½in. mesh; 6in. screened to pass ¾in. mesh; 6in. screened to pass ⅜in. mesh, rejected by ⅛in. mesh; and 3in. of clean washed gravel.

The limit of oxidisable impurity allowed by the Mersey and Irwell Joint Committee, is such as will absorb one grain of oxygen per gallon of the sample in four hours. The limit as regards nitrogenous organic matter is such as will evolve on boiling with alkaline permanganate ·1 grain albuminoid ammonia per gallon of the sample. In most cases the first of these was actually complied with in the effluent produced, and in the case of one of the filters, E, the effluent from which is given from January to April of this year, the analyses show that the standard was much below the required limit, the average not being much above ·5 grain per gallon. In taking this standard of purity into consideration one has to remember that the trade refuse will frequently absorb oxygen, but at the same time be non-putrescible. The investigators are clearly of opinion that the absorption of oxygen beyond one grain per gallon in four hours—as a fact it was only once as high as 1·3—is due to trade refuse, and does not imply that nuisance would follow. The albuminoid ammonia does not, as a rule, show such extreme variations as the oxygen absorbed, the latter being, as already pointed out, due to town refuse, which has comparatively little influence on the amount of albuminoid ammonia. In several cases where the samples infringed the standard as regards oxygen absorption, they are found to comply with the standard as regards abuminoid ammonia—"a circumstance," says the report, "which serves to greatly reduce the gravity of this infringement." A table is given dealing with samples of effluent from one of the beds and from the Ship Canal taken nearly every day from July 6th to September 13th this year. In every case, after the incubator test and a three minutes' absorption of oxygen, the effluent was found to be non-putrefactive; in no case was a mixture of equal parts effluent and Ship Canal putrefactive, and in only six instances out of forty-nine was the mixture "questionable." In all forty-nine cases the Ship Canal water, "pure" and simple, was found to be putrefactive under similar conditions.

There is a quantity of most instructive and interesting matter in the report which we must pass over for lack of space, contenting ourselves with the foregoing brief outline, and passing on to the conclusions and recommendations contained at the end of the report. The investigators say that the bacterial system is the system best adapted for the purification of the sewage of Manchester; any doubts which may have arisen in the first instance as to its suitability, owing to the presence of manufacturing refuse, have been entirely banished. The results obtained have exceeded expectations as to the possibility of purifying a manufacturing sewage, inasmuch as it was previously a matter of common belief that in such a liquid only a most insignificant amount of nitrification could be induced. Taken broadly, the first contact bed produces a purification of 50 per cent.; the next bed a purification of 50 per cent. of the impurities remaining after the first bed; and so on.

In order that a bacterial contact bed may exercise its full powers of purification, it is necessary—(*a*) That it should be allowed sufficiently frequent and prolonged periods of rest; (*b*) that the sewage applied to it should, as far as possible, be free from suspended matters; (*c*) that the sewage applied to it should be of as uniform a character as possible.

These conditions are secured by passing the sewage as it arrives at the works through an adequate system of screens, catchpits, and tanks. Such an arrangement has the further important advantage of leading to the development of those anaërobic or septic processes which resolve into gaseous and soluble products the organic suspended matter present in the sewage. A large proportion of the sewage sludge which would otherwise accumulate, and the disposal of which is the source of so much difficulty and expense, is thus abolished. The above anaërobic or septic process is found to take place as effectively in an open tank as in a closed one. The capacity of bacterial contact beds has been found to remain practically constant after they have been in operation for a period of three months. This capacity is best referred to the empty tanks, the measurement being taken to the line which corresponds to the surface of the clinkers which are subsequently put in. The constant water capacity of the beds has been found on this basis, in round numbers, to be about one-third of the tank capacity. With regard to the amount of sewage which can be purified by a given bed without the latter being overtaxed, prolonged experimental inquiry has shown that each bed may safely receive four fillings in the twenty-four hours, provided the sewage has undergone the preliminary subsidence and septic preparation in tanks, and that the bed is accorded about one day's rest in every week. In the event of a bed having been unduly taxed, its efficiency is only temporarily impaired, and can be restored by a few days' repose. The bacterial system is efficacious at all seasons of the year.

In view of the experience gained during the experiments, the following recommendations are made:—

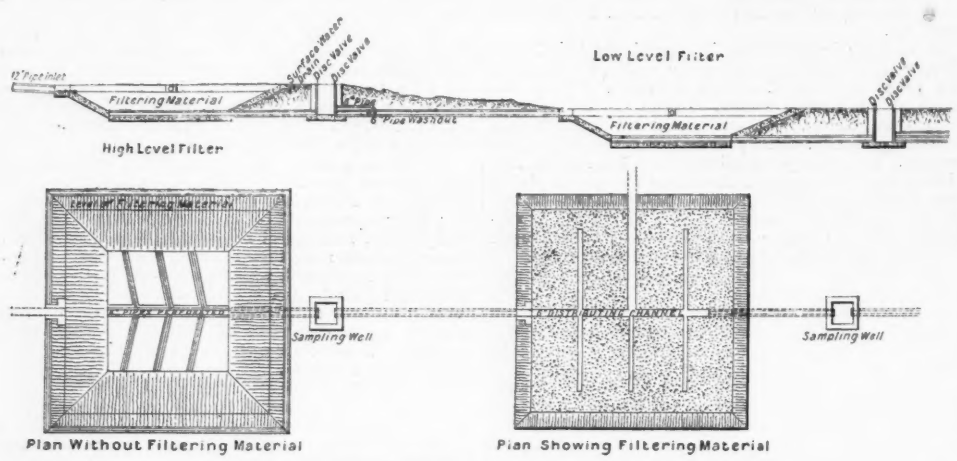
(1) That the sewage as it arrives at the works be submitted to an efficient process of screening, and that it be passed through the present open tanks. These tanks should be provided with submerged walls and floating scum boards, so as to retard the flow of the mineral and organic matters in suspension. In the event of the present machinery proving insufficient to remove the heavier mineral matters in suspension, it would be desirable that four roughing tanks should be added to the present tank arrangements, or that four of the existing tanks should be converted into such roughing tanks, and that four additional tanks should be provided to take their places.

(2) The effluent from the open tanks is to be passed through the double contact beds. Of these double contact beds it is estimated that there should be an area amounting in round numbers to 60 acres, exclusive of retaining walls, roads, &c. This estimate is based on a dry-weather flow of 30 millions, and on the supposition that each acre, being laid out in beds of 3·33ft. depth, with four fillings per twenty-four hours, would be capable of dealing with half a million gallons of sewage in round numbers, allowing for one day per week rest. The bacteriological or biological beds would be constructed in pairs, high level and low level, of about half an acre each, for the purpose of being able to get the sewage quickly upon them. The arrangements for draining the filters now proposed to be constructed are simply to form proper channels in concrete, covered with perforated slabs, without the use of pipes. Mechanical arrangements will also be made for the purpose of distributing the sewage over the surface of the beds, which is a matter of some importance; and the construction will enable the whole of the openings on to one bed to be simultaneously opened or closed, so as to avoid loss of time by the men passing from one opening to another. The final effluent from the various filters would be collected and conveyed into the existing deep-water culvert which passes through the lands at Davyhulme, and would thus convey the effluent into the Manchester Ship Canal below Barton Lock.

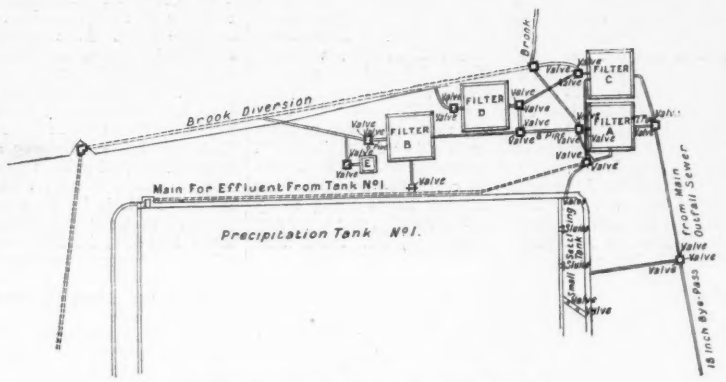
(3) The material recommended as most suitable for the bacteria beds consists of clinkers, of such a size as to pass a 1½in. mesh and to be rejected by a ½in. mesh. Efficient means must be provided for rapidly filling and discharging the beds. The beds should be so constructed as to allow of each being used independently.

(4) During the occurrence of a storm the flow of sewage should be dealt with in the system of tanks and double contact beds. The excess of flow, after passing through the roughing tanks, should be taken to specially prepared bacteria beds of an area which, it is provisionally estimated, will have to be of at least 25 acres in extent. As a safeguard against excessive quantities of storm water passing down at any time, the present sewage tanks may have an increased depth of water put upon them. At present the tanks have a capacity of 12·3 million gallons per day, and this may be readily increased to about 15 million gallons per day by raising the walls of the tanks.

The report finishes with the following statement:—"Finally, we may state our confident opinion that with the system of bacteriological treatment of the sewage of Manchester set forth above, an effluent will be produced which will not only conform with the Mersey and Irwell standard, but which will also materially improve the condition of the Ship Canal. Furthermore, as this system does away with the use of chemicals, and, at the same time, to a very large extent reduces the volume of sludge to be dealt with, it is obvious that much of the present expense will be saved by its adoption, and this saving may be taken as a material set off against the cost of the construction of the proposed works."



MANCHESTER SEWAGE—BACTERIAL FILTER BEDS



EXPERIMENTAL FILTER BED INSTALLATION

THE EXTENSION OF THE SOUTH YORKSHIRE COALFIELD.—The extension of the South Yorkshire Coalfield in the direction of Doncaster is still proceeding, and should a scheme which is under consideration become an accomplished fact it will be another step towards convincing co-operators that even colliery owners have not matters all their own way. A short time ago the Grimesthorpe Colliery Company, which is fast developing its colliery near Cudworth, leased the coal under the Frickley estate belonging to Mr. Aldam, and intends sinking to it in a short time. The coalfield—one of the finest in England—was broken into some years ago by the South Kirby Colliery Company, and is now largely worked. A scheme is in course of development for purchasing the Upton Estate, which is about the same distance from the South Kirby Colliery as Frickley, which lies in the opposite direction. The scheme is to be pushed forward by a compact known as the "West Yorkshire Co-operative Coal Federation," and the object in view is to provide a colliery which will feed some fifty to sixty of the leading co-operative societies of Yorkshire and Lancashire who are dealers in coal with the necessary fuel, evidently without its being pinched of first profits. It is stated that the Upton estate, which consists of 480 acres of land and coal, can be in all probability purchased at the rate of £100 per acre, whilst adjoining estates would furnish fully 5000 acres of coal, which it is thought could be secured. The maximum outlay is put down at £150,000, and the estate is said to contain seven seams of saleable coal, including the Barnsley 9ft. seam which underlies the estate at a depth of 634 yards. The scheme is to be brought before the various societies, and its development is being watched by coal-owners with a good deal of interest as a means of solving problems interesting to capital and labour alike. It is, however, said some of the societies are, to say the least, lukewarm on the matter, the Leeds Society having burnt their fingers some years ago to the amount of several thousand pounds. Whatever is the outcome of the scheme, it is more than probable that the estate will not be long before it is developed in the present state of the coal trade. The seams have been thoroughly proved, and the estate has the advantage of being in close proximity to the Hull and Barnsley line, and therefore in direct communication with the premier Yorkshire port for the shipment of steam coal.

THE GREAT NORTHERN RAILWAY.

NEW BRANCH LINE AND GOODS STATION AT LEEDS.

No. I.

It was in the session of 1893 that this branch line, which we shall proceed to describe and illustrate in the present and some succeeding articles, received the sanction of Parliament under the title of the "Hunslet Railway." In the following year, however, by virtue of the additional powers conferred upon the Great Northern Line, arrangements were entered into which ultimately caused it to become the property of that company. In July last the branch line and the goods station at South Accommodation Bridge, Hunslet, were opened for all descriptions of goods traffic. This station is conveniently situated for dealing with goods, grain, mineral, and live stock traffic for Hunslet and that portion of Leeds east of Call-lane, Vicar-lane, and North-street, and ample facilities are given for the prompt unloading of market produce under cover. The station and sidings cover an area of twenty-three acres in extent, and are fitted with all modern appliances for dealing with all descriptions of goods classes of traffic. The whole of the new premises are within easy reach of the extensive and important engineering works and other manufactories and industries situated in the district. A perspective view of the goods warehouse is shown by the photograph Fig. 1. While the body of the warehouse consists of solid brickwork, the openings are carried upon plate girders, supported upon steel columns, but the covered approach extending along the whole of the six-gabled *façade* is supported by cantilevers of the open web type. It may be remarked that the acquisition of this valuable site by the Great Northern Railway Company, solely due to the taking over and construction of the Hunslet branch, has been attended with very beneficial results to the public, and we trust to the company as well. For some time their goods station in Wellington-street has been with great difficulty adapted to meet the constantly-increasing demand of their traffic, and owing to the physical features of its location, it would have been a very difficult and expensive undertaking to enlarge it.

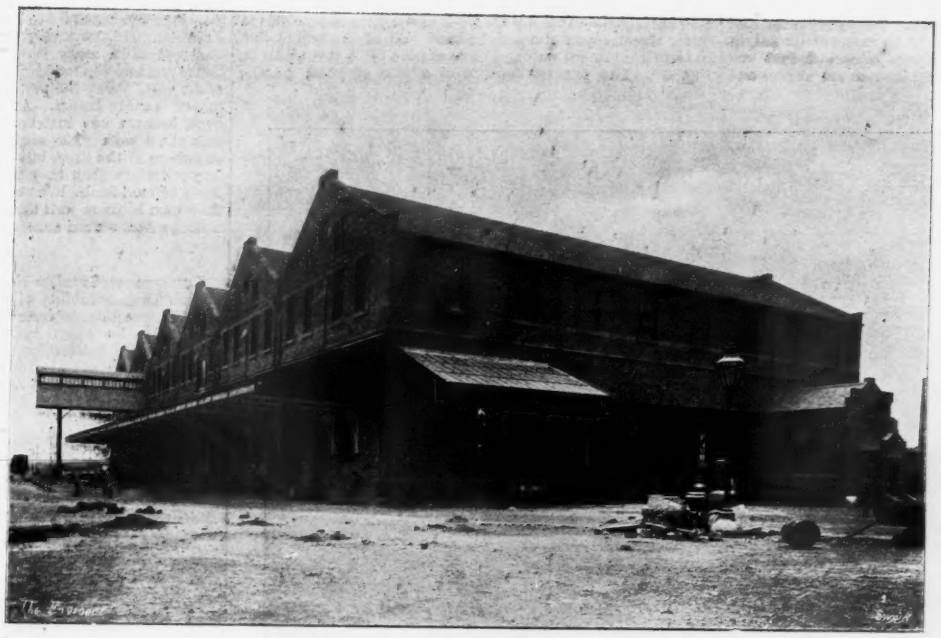


Fig. 1—GOODS WAREHOUSE

In addition to the twenty-three acres at present laid out for the goods station yard and buildings, an additional amount of land has been acquired by the company, in order to provide for the inevitable future extensions, which are certain to be required sooner or later. The existing site of the station is occupied by more than 8000 lineal yards of single track, with ample space for carting goods and merchandise of all description. An interior view of the ground floor of the goods warehouse, which is 300ft. in length by 124ft. in width, is given in the photograph, Fig. 2. It has three tracks running through it, and is fitted with ten hydraulic cranes, each capable of lifting 30 cwt., together with one crane for raising 50 cwt., and another equal to hoisting a load of three tons. In Fig. 2 the internal construction is very well shown, and, briefly—for the view is almost self-explanatory—consists of a series of bays or plate girders supported by brackets riveted to columns of a built-up section. Between the main plate girders in each bay, smaller girders running parallel to the rows of columns are attached, and upon them transverse joists are fixed, which carry the flooring of the storey above. On the floor above, which is represented in Fig. 3, a somewhat similar arrangement of plate girders and columns prevails; and the roof principals, which are of timber, rest upon the main girders. In each case the columns have been made strong enough to carry another storey should necessity ever arise. There are upon this floor ten 12 cwt. hydraulic cranes and a hoist for grain. Provision has also been made for extending the length of the goods warehouse, in the event of such a contingency becoming urgent.

The railway, a plan of which is given in Fig. 4, is three and a quarter miles in length to the commencement of the goods yard, which extends for a distance of three-quarters of a mile. It starts from a junction with the main line of the Great Northern Railway at Beeston, a station between Leeds and Wakefield. Continuing its course in an easterly direction, along the south side of Leeds, it skirts Beeston Park, and crosses over the Middleton Colliery, Midland Railway, and then curving towards the north, passes over the river Aire, between Knowsthorpe and Thwaite docks, and finally runs into the new goods station at South Accommodation-road. The entrance to the goods station is situated in close proximity to the new bridge over the river Aire, now in an advanced stage of progress approaching that of completion, which has been erected by the Corporation of Leeds, to facilitate the transit of the exceptionally heavy traffic which will take place between the new goods terminus and the neighbouring districts. In addition to other works, the North-Eastern Railway has constructed a short branch line from Neville Hill, built a new station contiguous to that of the Great Northern Company, and laid down all necessary sidings, extra tracks, and junctions, with the object of effecting an interchange of traffic between the two great companies.

It is evident that in making new railways which are not only in close proximity to large towns, but pass right through parts of them, the works must, at any rate at frequent intervals, be of an exceptionally heavy character, and the line under consideration, which has a double track throughout, and which borders upon the outskirts of the populous and wealthy capital of the West Riding of Yorkshire, is no exception to the rule. Although comparatively of a very short length, the standard of construction adopted is of the same high class as that which characterises the rest of the Great Northern Company's similar undertakings. A good part of the branch runs through cuttings, varying from 20ft. to 30ft. in height, and the ruling gradient is 1 in 100. The whole of the goods station and its belongings are laid out and built upon an embankment about, on the average, 20ft. high; but the maximum height of the embankments attains to 40ft., which occurs in the approaches to the bridge, which carries the line over the river Aire, by a very fine swing bridge of exceedingly large span, which we shall describe and illustrate very fully in a subsequent article. Among the principal works of construction deserving especial notice and consideration are the eleven bridges under the railway, two viaducts of four and five spans respectively, six public road and three footbridges over the line. In all cases mild steel is the material employed for the bridges, and it was specified to have an ultimate tensile strength of 27 to 32 tons per square inch of section, and an elongation of 18 to 26 per cent. As a parallel example, it may be mentioned that the specification for steel in tension, in the Forth Bridge, was 30 to 33 tons, with an elongation of 20 per cent., and for steel in compression 34 to 37 tons.

Fig. 2—GROUND FLOOR, GOODS WAREHOUSE

Fig. 3—UPPER FLOOR, GOODS WAREHOUSE

Fig. 4.

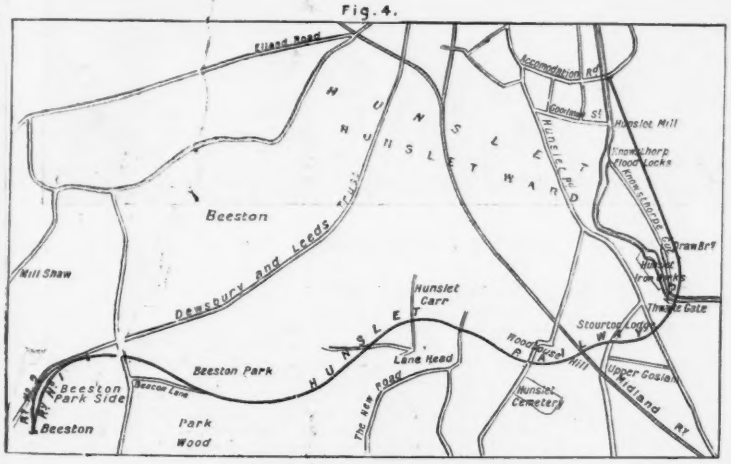


Fig. 4—MAP OF HUNSLET RAILWAY

In order to make due provision for meeting the requirements of the great augmentation in the weight of locomotives, which appears to be a continually increasing quantity which

has not yet reached its maximum, the design of the under bridges has been regulated accordingly. They are all able to carry locomotives of the heaviest type, with 21 tons upon each of three axles, placed 6ft. 6in. to 7ft. 6in. apart. With this amount of loading, the stress induced upon the principal members of the girders and trusses will not exceed from five to 5½ tons per square inch in tension, and from four to 4½ tons in compression. Commencing from the junction with the main line at Beeston, the first work of importance is the viaduct carrying the line over the valley near the Middleton Colliery, which, similarly to many of its neighbours, is on the skew. It may be here remarked that one of the principal points of difference between the earlier and

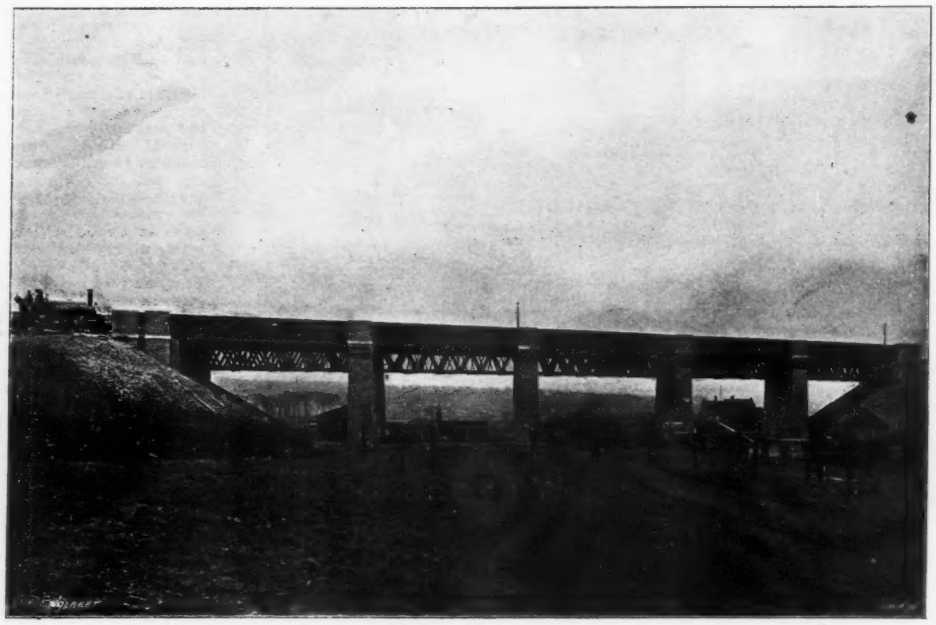


Fig. 4a—MIDDLETON COLLIERY VIADUCT

the more modern railways is to be found in the far greater number of bridges on the skew which characterise the later lines. This fact was very conspicuous in the numerous bridges upon the northern division, from Annesley Junction to Rugby on the Great Central Railway, of which a detailed description, accompanied by plans, photographs, and valuable working drawings, appeared in our columns a short time ago. The cause for this notable difference is not far to seek. In the first place, the span of skew arches, whether turned in brick or stone, is comparatively very limited, and, in addition, English engineers disliked them. Secondly, it was the employment of cast and wrought iron in the construction of railway bridges which gave the *coup de grâce* to the older structures.

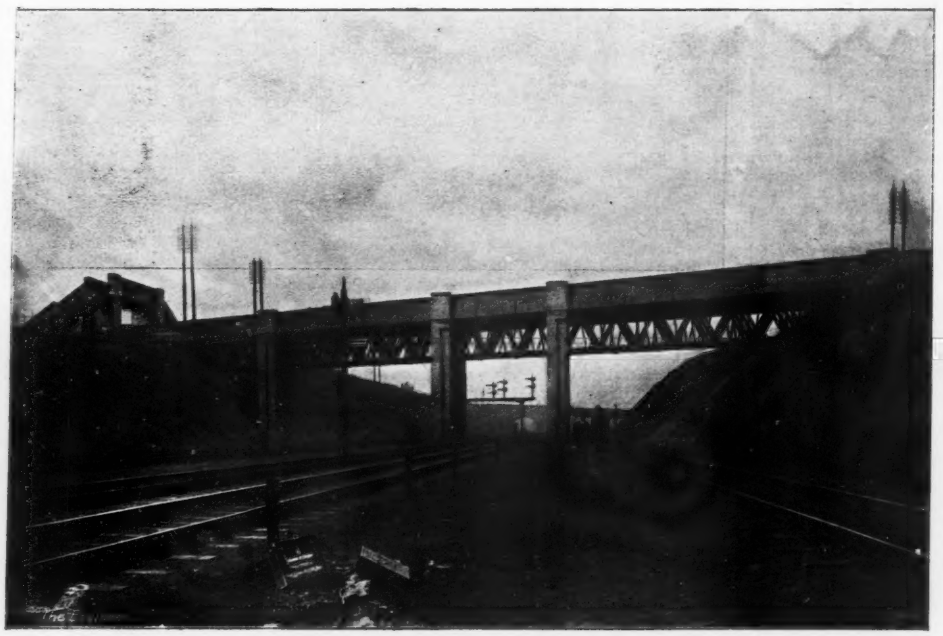


Fig. 12—BRIDGE OVER THE MIDLAND RAILWAY

It is an equally simple matter to build a steel bridge on the skew as on the square; and it is fortunate that it is so, because of another cause which has greatly contributed to increasing the numbers of the former class. Modern railways do not run nearly so much in the open as the earlier lines did, and the streets and thoroughfares of large towns cannot be diverted with the same impunity and indifference as a country road. The axes of the two lines of traffic cannot be brought perpendicular to each other, and the streets must be crossed as they are located, irrespectively of either the sharpness of the angle of skew or the magnitude of the span thereby rendered inevitable.

The viaduct across the valley near the Middleton Colliery, of which a photograph is given in Fig. 4A, consists of five spans upon an angle of skew of 58 deg. 30 min., and is better shown in the elevation and plan in Figs. 5 and 6. As the girders, owing to the liberal allowance of headway, are placed beneath the rails, the bridge belongs to the through system, and the girders are examples of the old Warren type of single equilateral triangulation. Their respective spans are 55ft. 1½in., 53ft. 1in., 54ft. 3in., and 62ft. The girders are 7ft. in depth, and both the upper and lower booms are of the usual trough section. Cross sections on the square are shown in Figs. 7, 8, and 9, from which it will be seen that the approaches are carried on an embankment 30ft. in width, and having slopes of 1½ to 1. A small stream is diverted under the end span of the right-hand side of the bridge, and the small retaining wall and cross section of it are given in Fig. 10. The parapet consists of a pair of plate girders, 5ft. 6in. in depth, placed outside the main trusses. The remaining photograph—Fig. 12—is a view of the bridge over the Midland Railway, which will be further referred to in our next article.

DOCKYARD NOTES.

THE naval event of the week is the arrival of the German Emperor at Spithead, or rather of his brand-new ironclad Kaiser Friedrich III. This ship has been lately overhauled, and now bears very little resemblance to the picture of her in the current *Naval Annual*. The military mast forward has been much reduced, and the tops of the mainmasts have been lowered a good deal. Possibly her stability was not all that could be desired. On the other hand, the funnels have been heightened, and are now simply colossal. The ship is a huge target, but despite this the funnels look abnormally large. However, whatever defects the Kaiser Friedrich III. may possess, she can steam well: she made eighteen knots towards Spithead—a spurt, doubtless—still she made it, and eighteen knots was her trial speed. She has Thornycroft boilers, which this country has never tried in anything larger than a little third-class cruiser.

THE smoke made by the Germans—except the Hohenzollern—was prodigious. Probably the Imperial yacht is outside the patriotic regulation which orders German ships to burn German coal.

THE newspaper accounts of the affair are chiefly remarkable for inaccuracy. Not only did the destroyers not leave on Sunday, but they did not join the Spithead fleet at all. They went out to meet the Germans by themselves. On the way back up harbour a curious incident happened. According to programme the Hohenzollern was to go first, astern of her the eight destroyers, then the Kaiser Friedrich, III., Hela, and German division boat. The Germans upset this arrangement, pushing our destroyers out of the way, so that a little inside Southsea Castle they had to stop. The Kaiser Friedrich III. was then well ahead, the Hela following was not 50ft. away from our Flying Fish, the leading destroyer, and she made not the slightest attempt to get out of the way. Why the programme was not adhered to, no one in our service knows. Attention is drawn to the matter here, because our instructional flotillas coming in did not look at all well. The eagle eyes of the British Press were elsewhere at the time, but German naval critics were about. Any criticisms that they may make in their service papers must be read in the light of these facts. The Germans work their own boats so well that they are not likely to be lenient critics where we are concerned.

THE armoured cruiser Sutlej has been launched at Clydebank. The advisability of building big armoured cruisers is open to question, because of the risk that an admiral will hesitate to let them leave the fleet, and they will thus become weak battleships. As armoured cruisers go, the Sutlej is an excellent ship; the trouble, if it exists, lies in her excellence! Still, if other nations build such vessels, we are almost bound to build them too.

THE new Clydebank destroyer Electra reached Portsmouth last Friday. She is a three-funnelled craft, the amidships funnel being very large.

THE Shikishima, Japanese battleship, made seventeen knots natural draught, and 18·78 forced draught, on her trials. She is hardly likely to leave England this side of Christmas; but the story of delayed guns must be taken with a pinch of salt. She had all her guns on board two months ago.

THE new American armoured cruisers will carry 10in. guns as their main armament.

THE Orlando's converted 6in. quick-firers have done pretty well on the China station. The best gun made five hits with seven rounds. Some, however, were not by any means so good, as, with thirty-six rounds, these others only totalled twelve hits. The bow 9·2in. made five hits with ten rounds; the after gun fired eight rounds and got three hits. This beating of the after gun, which naturally shoots best, is worthy of note.

DECEMBER 5th is the day fixed for the commissioning of the Canopus. She is going to the Mediterranean, as was stated in this column a year or so ago. The rumour that she would replace the Resolution in the Channel was merely an idea manufactured in London. Probably the Resolution and her sister will eventually be replaced by two more of the Majestic class, now elsewhere. All the Canopus class and subsequent ships are likely to find their way to the Mediterranean, while the Royal Sovereigns will become the port guardship and Reserve squadron. To put the Canopus in the Channel would merely be to add a fresh odd type. The Hood is coming back from the Mediterranean, and, it is to be hoped, will replace one of the Admirals in the Reserve, for these vessels are notoriously unfitted to make a strong Reserve fleet. They are called "first class," but "third class" would be nearer their fighting value rating.

THE *Naval and Military Record* has a comic touch in its issue of November 16th. In its dockyard letters certain big battleships appear with the dates of their laying down, launching, &c. At the end follows:—"Building: Pandora, laid down January 3rd, 1897." At the present rate they seem likely to be able to repeat this well into the next century. Still, to "give the devil his due," it should be mentioned that the Pandora is a "stand-by" ship, upon which men work when there is nothing else for them to do. It saves many discharges, or might save them; and after all, a small third-class cruiser more or less will not make any difference to the British Navy.

A REMARKABLE PATENT SPECIFICATION.—A recent issue of the official gazette of the United States Patent-office contains a very remarkable document. It is the statement of claims for a voting machine, by Mr. James H. Dean, of St. Paul's, Min. It is understood that a patent in the United States can cover one invention, and one only. Mr. Dean makes 359 claims, occupying over fourteen large octavo pages in very small print. Whether he has really contrived to patent only one invention we are not prepared to say. To a certain extent, the claims run on the old familiar lines of "This is the house that Jack built," so dear to the American patent agent, but in this case there are several houses built by Jack. Altogether, it is a very remarkable legal document.

TRIALS OF A JARROW DESTROYER.—H.M. torpedo boat destroyer Spiteful, built and engined by Palmers' Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne, has just completed her official trials at Portsmouth. The first trial was stipulated to be at a speed of about 29½ to 30 knots for three hours to test the consumption which was not to exceed 2½ lb. per indicated horse-power. It was found that at 29·9 knots the consumption was at the low rate of 2·3 lb. per indicated horse-power per hour. On the second trial the vessel was to be driven at not less than 30 knots during three consecutive hours, but at the same time it was desired to keep the speed as little in excess of the 30 knots as possible. On six runs over the mile the speed was easily maintained at 30·371 knots, and the engines were then adjusted so that the average of the three hours came out 30·06 knots. On the final, or twelve-hours' trial, the vessel was to be run at a speed of 13 knots and the consumption measured. The average speed was 13·05 knots, the power 450 indicated horse-power, and the consumption is officially given as being at the rate of 1·51b. per indicated horse-power per hour, so that the coal she is capable of stowing would at this rate enable the vessel to steam about 4000 nautical miles. She is generally similar to the other 30-knot boats by Palmers, and has two sets of triple-expansion engines and four Read's patent water-tube boilers working at 250 lb. pressure and 6300 indicated horse-power.

HUNSLET RAILWAY—VIADUCT AT MIDDLETON COLLIERY

(For description see page 513)

Fig. 5. Elevation.

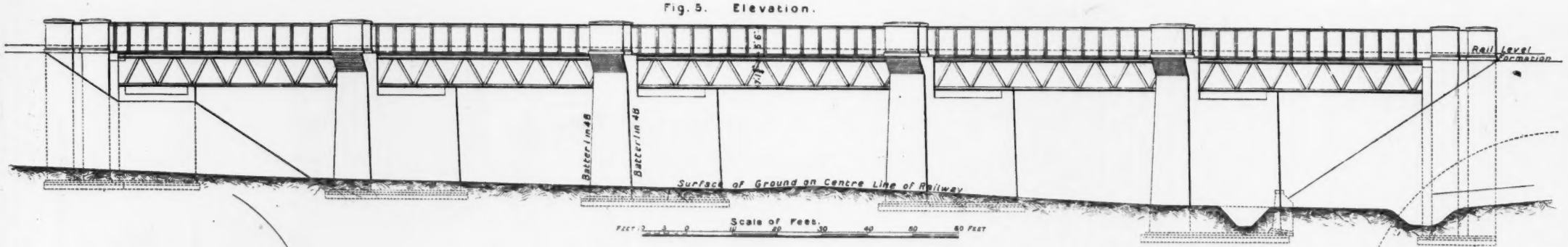


Fig. 6 Plan.

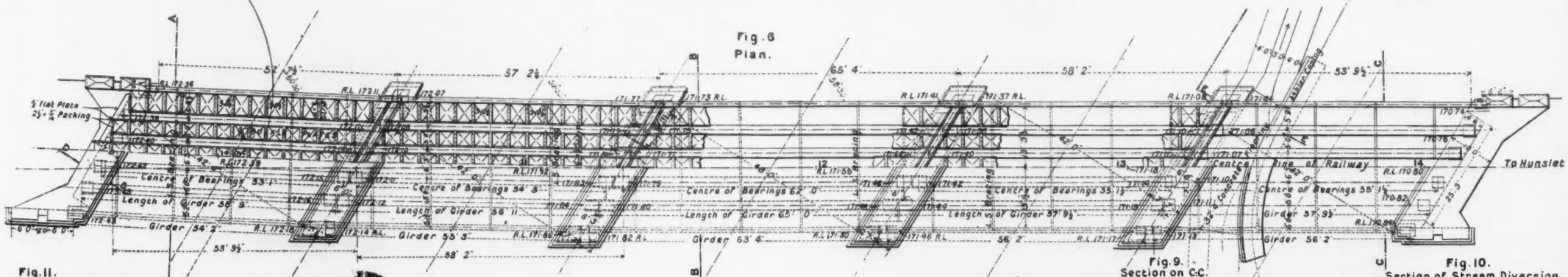


Fig. 11. Section through Abutment D.D.

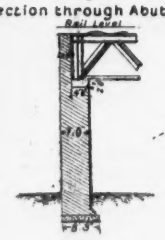


Fig. 7. Section on A-A

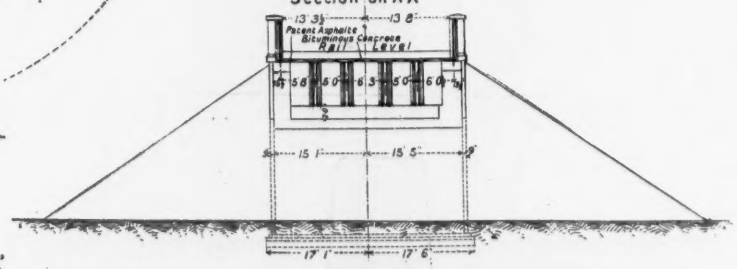


Fig. 8. Section on B-B

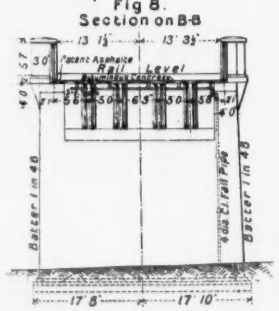


Fig. 9. Section on C.C.

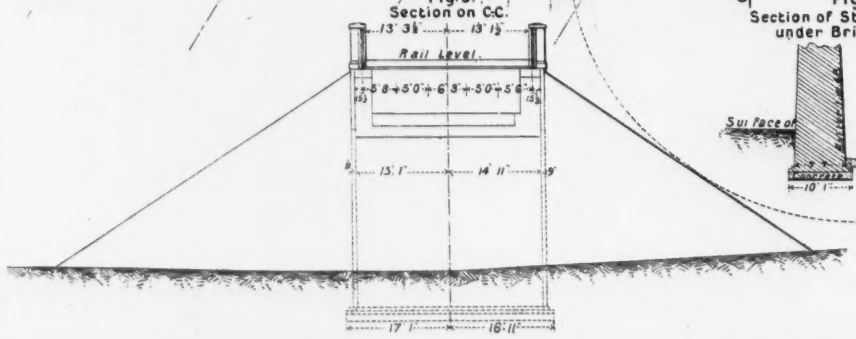


Fig. 10. Section of Stream Diversion under Bridge E-E.

"THE ENGINEER" SHAW ENG.

A GERMAN CABLE STEAMER.

THE launch of the first cable steamer built for Germany took place on the 8th inst. She was named Von Podbielski, after the present chief of the German Postal Department, and has been built by David J. Dunlop and Co., of Port Glasgow. This new steamer has been specially designed for cable laying and repairing purposes. Her principal dimensions are:—Length between perpendiculars, 255ft.; breadth, moulded, 35ft.; depth, moulded to underside of main deck, 16ft.; depth, moulded to underside of spar deck, 23ft. 6in. She has been constructed under the rules of Germanischer Lloyd to obtain their highest class—100 A 4—in steel as a spar-deck steamer, and when fully equipped for sea will have a deadweight carrying capacity of about 1300 tons, on 16ft. 6in. draught of water. Her speed when laden with 500 tons deadweight is expected to be 13 knots on the trial trip. She has a cutwater stem and elliptical stern, the paying-out and picking-up gear fitted on stem and stern being so arranged as to reduce as far as possible the rubbing of the cable on the hull when it is handled. The upper deck is flush all fore and aft, giving an unobstructed lead from the different cable tanks to the picking-up and paying-out machines at the bow and stern. The rig of the steamer is that of a two-masted fore-and-aft schooner, the masts being of steel, and at each mast is provided a steam winch, with all appliances for working the derrick when handling buoys, grapnels, &c. The spar deck is of teakwood, and the main deck is of pitch pine. The 'tween decks accommodate all the necessary hands for working the steamer, and the after portion is fitted for the cable officers, and includes a saloon and state rooms. The entrance to the cable officers' apartments will be approached from a large steel deckhouse, having a double-way stair.

Forward of the boiler-room bulkhead in 'tween decks for a distance of 64ft. accommodation is provided for all the cable hands, with a large testing-room, workshops, state rooms, &c. The quarters for seamen and firemen are placed abaft the collision bulkhead. The cable machinery has been supplied by Johnson and Phillips. The main forward portion, comprising engines and picking-up gear, occupies the space between the crew's quarters and the rooms for the cable hands on the main deck. On the spar deck, forward of boiler casing, a large house is fitted up, the after part containing a steam steering gear by Alley and McLellan, and the forepart a large room for the chief navigating officers. Overhead is built the flying bridge, in which is placed the chart and wheelhouse.

The cable tanks are three in number, the first and second being arranged forward and the third aft. Each has a cone in the centre, 6ft. diameter at bottom, and 3ft. 6in. at top. The capacity of the tanks is about 20,500 cubic feet. Deep water ballast trimming tanks are fitted on the McIntyre principle, the tops of which form the bottoms of the cable tanks in the forward and after holds, having a capacity of about 300 tons. There are pumping arrangements for all the several compartments. The equipment of the steamer includes a direct steam capstan windlass by Emerson, Walker, and Thomson, six boats, and hawsers, anchors, and chains, to the requirements of Germanischer Lloyd. There is a complete installation of electric light, which has been supplied by Wm. Harvie and Co., together with an Admiralty type 20in. projector, and all the customary modern appliances for a steamer of this description.

HENDEY-NORTON SCREW-CUTTING LATHE

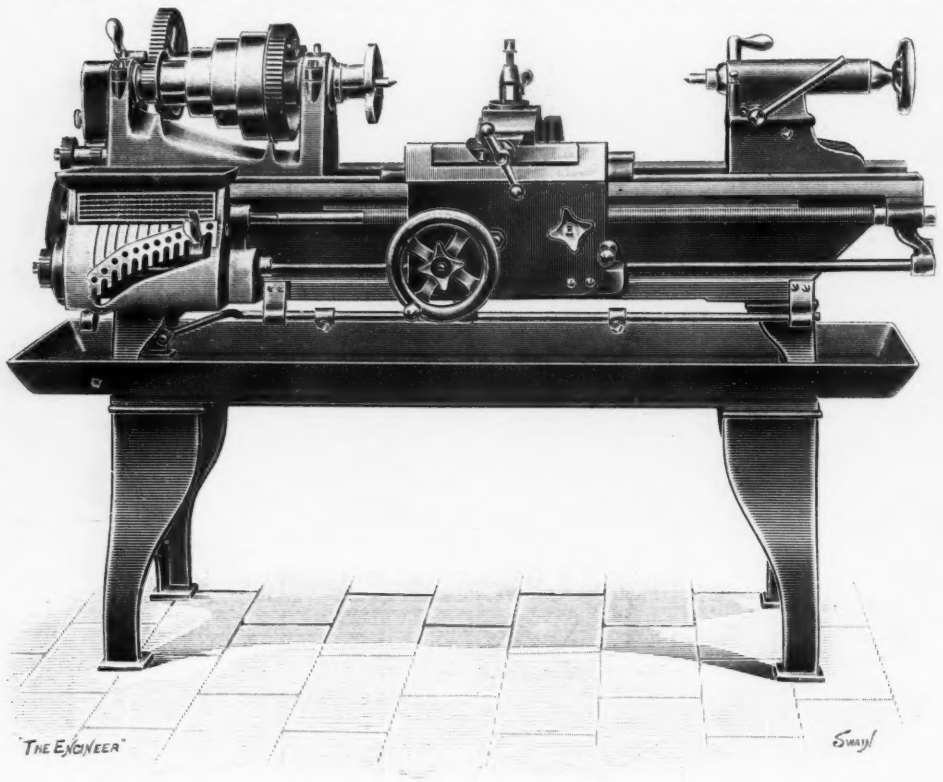


Fig 1

MACHINE TOOLS AT THE CYCLE SHOWS.

We have already dealt with some of the most important machine tools exhibited at the Stanley and National Shows. There are, however, several which remain to be mentioned. In the first place, we wish to complete the description of the Magazine machine, made by Pratt and Whitney, and exhibited by Buck and Hickman at the Stanley Show, which was illustrated in our supplement last week, as at that time we had not seen the machine in operation, and were unable to give a detailed explanation of its working. We have now spent some time in watching the machine, or rather the machines, for there are two of them running at work, and have looked fully into their points with Mr. Randles, who has brought them over from the United States.

The machines are, of course, quite novel in England, and it is only comparatively recently that they have been used in America. They have been principally employed so far by makers of cotton mill machinery, turning out spindle gears, bolsters, bolster-cases, and such like articles, by the hundreds per day. But their use is extending into other fields; they are, for example, being used on the parts of telephones and sewing machines, &c., and, in fact, for any class of work where a great number of similar small castings or forgings have to be made. The machine itself resembles very closely the Hartford automatic machine, the addition of a cam for working the magazine, and an alteration to the spindle to suit it for the type of chuck used being the principal modifications. In order to explain the working, we will follow the machining of a spindle head through its various operations. We reproduce again a full-sized

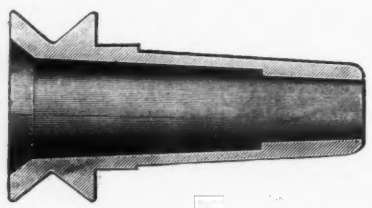


Fig. 2

section of the finished casting so as to make the description clearer — Fig. 2. Two machines are required to produce one of these articles. Probably before long we shall see all the work done on one of the same type somewhat as the Hartford double-spindle screw machine. At present the smaller part is done in one machine and the larger part in another. The castings consist simply of a large plain cylindrical part and the shank—there is no attempt to core the hole or to shape them in any way further. The hopper or magazine is fitted above the chuck. It is bent in a sharp knee away from the operator, evidently to economise height and to bring the loading end on the operator's side of the lathe. Twenty-five castings, about two hours' work, fit into it. In the first operation machine the shanks all project from the side of the magazine, the castings being kept in by their heads. At the lower end of the magazine is a carrier which is moved up and down by a cam on the cam shaft. As it goes up it touches a trigger which releases one casting, which rolls down into the carrier, where it rests between a pair of spring valves. At the right moment the carrier with its charge comes down. Instantly the turret moves forward and a spring of tubular form is thrust over the projecting end of the casting. The carriage then rises, but the casting is pulled through between the leaves of the valves. As soon as it is free the turret carries it forward between the jaws of a chuck which immediately close on the big end and hold it. This chuck is merely a modification of the ordinary wire-feed device. The turret then retires and turns round, bringing a turning tool into position. It will be noticed that the shank is taper, whilst the neck is parallel. The turning tool is kept up to its work only by a hard steel plate at the back along which it slides. This plate can be set to any desired angle of taper. In the carrier which holds the turning tool is also a cutter which chamfers off the end and starts a centre. This done, the turret again retires, turns automatically, bringing a twist drill into position. When it is fairly started the cross slide comes into action and faces up the shoulder, the same tool cutting the parallel part. The last operation on this machine is done by a formed scraper, fixed in the last hole in the turret, which finishes the shank off exactly to size. Whilst this is going on a pin runs into the hole to steady the work. Finally, the turret retires, the chuck opens and drops the casting, which falls down behind the machine, and down a zig-zag into the front again.

In the second operation machine the castings are put into a rather differently-shaped hopper. No part of them projects, and the larger end is presented instead of the smaller. Right through the casting is the small parallel hole made by the drill. Into this hole a split pin, projecting from the turret, is pressed; a cone on the shank of this pin opens the valves and releases the casting, and the carriage, as before, rises out of the way. The turret continues, and pushes the shank of the casting into the hollow spindle, where it is promptly held by the chuck. The turret retires and partially rotates, bringing into play three tools, projecting into a cup, which rough off the outside of the casting. The next operation is drilling with a larger drill to a certain depth, and cutting the groove with the cross slide. Then a boring tool, like a coarse reamer, roughs out the internal taper and cleans the face, and finally a fine reamer finishes the taper hole correctly and gives the little internal chamfer. That done, the chuck is released, and a rod inside the spindle pushes the casting out finished all over to the $\frac{1}{1000}$ of an inch. A blast of air is kept continually blown through the spindle to keep out chips and turnings.

From this description of the manner of performing work of one sort, our readers will be able to understand how other similar things could be done. Of course, each machine is only fitted for one special job. It is true that with a little trouble it might be converted for other uses, but, speaking as a whole, a machine leaves the makers fitted to work on a certain model, and nothing else can be done on it. Such machines, therefore, may be con-

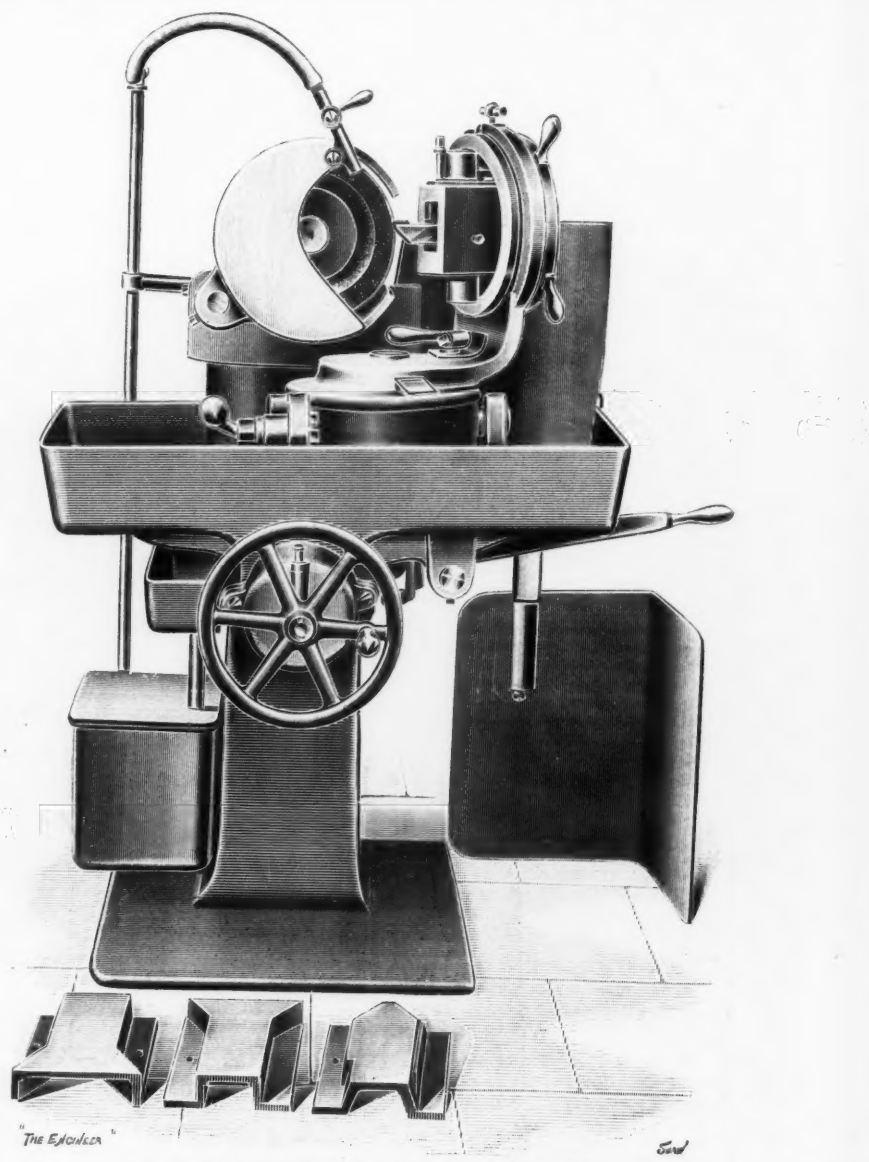


Fig. 3—GISHOLT UNIVERSAL TOOL GRINDING MACHINE

sidered highly specialised, and are only suitable where a large amount of repetition work is demanded. This is best understood when it is remembered that the makers will guarantee a turnout of 150 pieces per day of ten hours in English cast iron from these machines, and perhaps 25 per cent. more with soft American iron.

The applicability of such machines is therefore limited. To the general engineer they will scarcely appeal, because he rarely turns out articles at such a high rate, except bolts and screws. But to the manufacturers of sewing machines, typewriters, bicycles, and similar articles, it must unquestionably prove useful. It must not, however, be supposed that only small chuck work can be done. Machines are now at work dealing with hand wheels up to 5in. in diameter. They are chucked inside the rim, and are finished on one machine. It is probable that within the next few years remarkable developments of this type of tool will take place.

Although these tools are by far the most interesting on Buck and Hickman's stand, and were naturally attracting most attention, there are many other things quite worth seeing. Most of them have been, however, already described in THE ENGINEER. Amongst the smaller things we noticed that several alterations which have added not a little to its value have been made in the Randle die holder. At the end of the shank there is now fitted a screw by which adjustment for the length of thread to be cut can be made, and four pins are now used instead of two. The workmanship and finish are of remarkable excellence.

Amongst American lathes intended for general engineering use there are few superior to the Hendey-Norton screw-cutting lathe, exhibited at the Stanley Show by Charles Churchill and Co., Ltd. We give, Fig. 1, an illustration of the latest type of this machine. The distinguishing feature about these lathes is, of course, the change gear for screw-cutting, which can be seen beneath the head. It consists simply of a series of spur wheels of different diameters, and a pair of wheels which gear together, one of which may be raised into position with any one of the set of wheels by a lever. This gear gives every feed and thread in daily use; but outside change wheels can also be employed when necessary, so that a very great variety of feeds and pitches can be obtained. The gear is very simple and effective, and has gained a wide popularity. It is worth remarking that its invention dates back more than twenty years; but it is only within quite recent years that it has come into use. One or two other points about this lathe may be noticed briefly A very useful feature is a reversing device operated by a handle from the apron, which can be used for all feeds and for screw-cutting, so that the spindle may run continuously in one direction, and two straight belts from the countershaft can therefore be employed. An automatic stop which arrests the motion of the carriage at any desired point is also to be noticed. The larger sizes of this lathe are fitted with the Homan patent elevating rest.

We also noticed on Charles Churchill and Co.'s stand several Brainard milling machines. Some of these were especially arranged for tool-room work, and their handiness, and the ready means of adjusting and working them, should make them very serviceable in that direction. Some other tools which are shown on this stand were noticed in our supplement last week.

As the importance of preserving the correct shape of tools has come to be more and more recognised as essential to economical and accurate work, so the invention of tools for securing this end has progressed. One of the most complete grinding machines is that made by the Gisholt Machine Co., and exhibited by Burton, Griffiths and Co. An illustration of it is given in Fig. 3. from which the general form and construction will be understood. The main point of the machine lies in the clamping and setting devices, which render it easy to duplicate any tool which can be treated on such a machine.

There are four main structural parts in the machine. A column in which is journalled the emery wheel arbor, and through which is forced the heavy circular arm on which the pan oscillates. An oscillating pan supporting the tool holder, and having a transverse motion on the arm. It is rocked by the handle on the right and fed forward by the hand wheel in front. A tool holder provided with a tool clamp and graduated circles, by means of which the tool may be made to assume any desired position with respect to the emery wheel, and a tubular emery wheel mounted on an arm about which the pan oscillates. As grinding takes place on the side face of the emery wheel, it will be easily seen that flat surfaces may be ground by oscillating the pan by means of the hand lever at the right of the machine. The arbor is made of crucible steel, is ground on dead centres, and fitted to the long bronze boxes by scraping. The journals are cylindrical. The boxes are tapered on the outside and are adjusted by nuts on either end. An end thrust bearing is provided at the outer end of the spindle.

The tool-holder is fitted to the upper surface of the pan in such a manner as to slide in a direction parallel to the above, and it has adjustment about four different centres, so that all types of tools, either straight or bent, may be ground. It is perhaps worth mentioning in this connection that an excellent descriptive pamphlet is issued with this machine. In it, not only is the operation of the machine and its construction described, but a valuable table showing the best angles for grinding tools for various purposes is also given.

Burton, Griffiths, and Co., are also showing several milling machines made by the Garvin Machine Company, of New York. This house manufactures a great variety of tools of this class. We have selected for illustration one of their most recent types. It is a fairly large machine driven by a 3¼in. belt, and having a length of automatic feed of 26in. The extreme distance from the centre of the spindle to the top of the table is 18in., and the greatest distance from the end of the spindle to the outboard bearing is 24in. The principal feature about the Garvin machines of recent design is the feed change. No less than eighteen changes of feed can be obtained without moving a belt or touching a wheel, by simply turning a handle round into specified positions on an index disc. At our request Burton, Griffiths, and Co., very kindly removed this change-speed mechanism from a

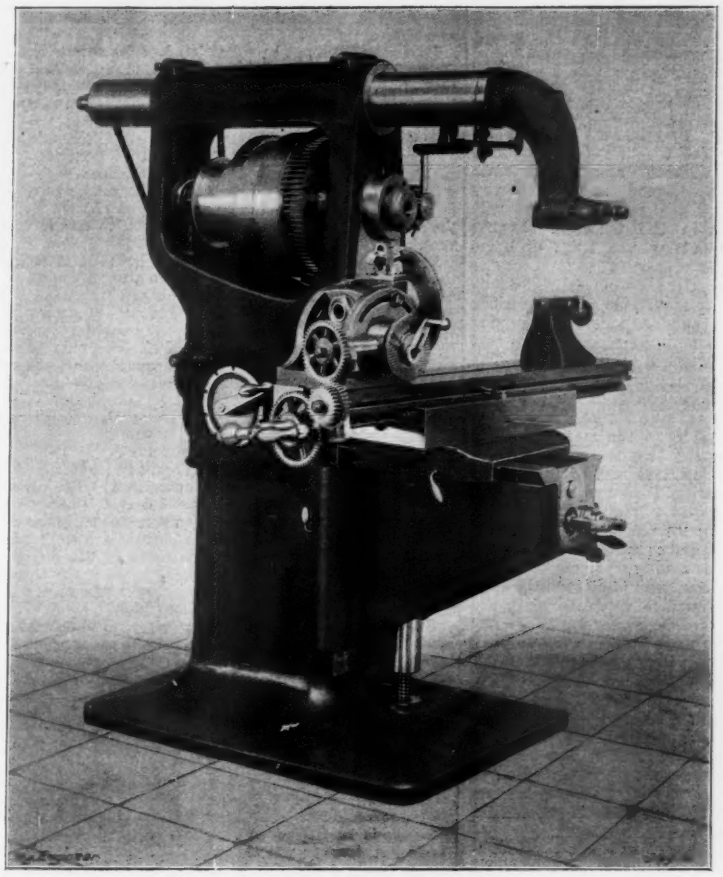


Fig. 4—GARVIN MILLING MACHINE

No. 4 machine they had in their showrooms in Ludgate-square, and had it photographed. We reproduce the photograph in Fig. 5.

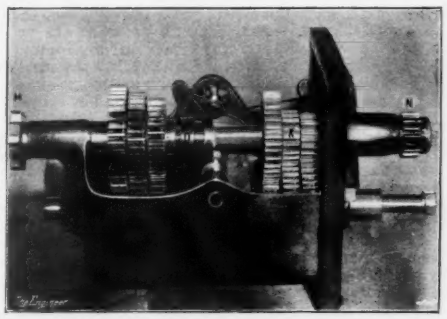


Fig. 5—GARVIN FEED GEAR

It will be seen that a number of wheels mounted on two shafts are fitted into a cast iron box, which forms an oil bath. This box complete is put into the hollow column of the machine from the back and, bolted in position by the plate at its end. The shaft which crosses it centrally extends on the far side, and has the handle seen in the middle of the dial plate in Fig. 5 secured to

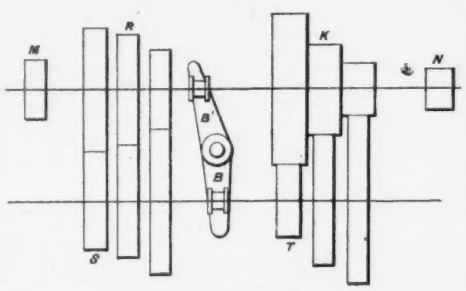


Fig. 6—GARVIN CHANGE GEAR

it. The wheel N is driven by an exterior train of wheels at a constant speed; the sprocket wheel M revolves at eighteen different speeds, depending on the position of the lever.

It is not by any means easy to make out the working of the mechanism from a mere inspection of it, because the lower shaft is almost hidden in the oil bath. This, however, is what it appears to be. The group of three wheels K are keyed together, and are driven at a constant speed by N. On the opposite end of the same shaft are three other wheels, all independent of each other, and loose on the shaft. But a collar D^1 on the shaft slides a feather into gear with any one of these wheels, and through it the chain wheel M is driven. Now the groups of wheels K drives another group on the lower shaft. These wheels are also loose on the shaft and independent of each other, but any one of them can be keyed to the shaft by a feather moved by a similar collar to D^1. Three other wheels are placed on the second shaft, and as any one of these comes into gear it drives the upper shaft and M. We have thus three speeds for the lower shaft, each of which can give three speeds to M, or nine speeds in all. Now, suppose that instead of K being driven by N, the opposite group is driven, and K is keyed to M, we evidently get an entirely new train with just the same number of changes, making eighteen in all. Perhaps the accompanying Fig. 6 will make this very ingenious mechanism clearer. We have four groups of wheels on two parallel shafts. In three groups all the wheels are separate, in one, K, they are all fastened together. Both shafts are hollow. Through the upper one runs a shaft to which N is attached. M is on the sleeve portion. Any one of the groups of wheels R can be temporarily keyed to the sleeve by a sliding feather, or the group K as a whole can be keyed to it. Any wheel of the group T can be driven by K, thus giving three speeds to the lower shaft, and each member of the group S can drive R, thus giving it a total of nine different speeds. A further change can be made by keying K to M, and allowing the group R to be driven by N. In this case, as all the wheels in R are of different diameters to those in K, we get another set of nine speeds, giving the total of eighteen.

The devices for moving the feathers to secure this variety of changes is fairly well seen in the photograph, and is indicated in the diagram. The index handle turns a plate A, in which there are a number of pins which gear with the four-toothed pin plate E^1 and its counterpart E, which is hidden in the oil bath. Both E and E^1 drive cranks C and C^1, which have crank pins working in slots in the levers B and B^1. By arranging the parts suitably, B^1 and B take up such positions as to secure the range of speeds desired. The amount of feed given by these changes varies from ·003in. to ¼in.

In all the Garvin machines a conical bearing for the spindle is used. It is of steel, and runs in a bronze bush. The taper of the cone is 5 deg. The thrust is taken on two hard steel washers backed by a soft steel washer, which can be removed and turned down to let the spindle further into its bearing. The rear bearing is straight, with an external taper box. The outboard bearing for the arbor is made of tool steel hardened and ground, and the telescope arm can be swung instantly out of position, or run in and out as required. It is clamped both front and back, and adjustable stays are provided to support the overhang on heavy work. The table is driven by a central screw, and is raised and lowered by a screw which does not have to pass through the floor. A dividing head with index circles of four, six, sixteen, and eighteen holes is supplied, and can be used in all positions of the head. Power feeds are provided in all directions.

Nothing very new is to be seen on the stand of Pfeil and Co., of St. John's-street, Clerkenwell, but there are one or two little items worth notice. One of these is a simple apparatus for cutting keyways in shafts. It can be fixed to a shaft in any position, and is driven by hand. A V-block with a pair of clamping screws is used to attach the machine to the shaft. The cutter, of the usual form, is attached to a spindle, on the other end of which is the handle for operating it. The tool is fed forwards by a small hand wheel on the same spindle. This spindle is mounted in a slide, so that it can traverse backwards and forwards to cut the keyway. A worm wheel is also attached to the slide, and is slowly revolved by the spindle. A connecting-rod is fastened at one end to the fixed part of the apparatus, and at the other end to the worm wheel, and at any desired distance from its centre. Thus, as the wheel revolves the cutter moves backwards and forwards. The whole device is exceedingly simple, and appeared to do satisfactory work. Pfeil and Co. are

also introducing a very simple portable hand centering machine. In the larger sizes, holes which are excentric to the centre line of the shaft can also be drilled. The usual form of combined drill and rose cutter is used. The machines are fitted with ball bearings.

Although the exhibitors of machine tools at the Crystal Palace are this year fewer than usual, the provision of electrical power by the Palace authorities has enabled those who have secured space to show their appliances in motion. Electrical energy at a pressure of 110 volts is supplied by a battery of de Laval steam turbine dynamo sets installed by Greenwood and Batley, Limited, Leeds. These appliances also supply the current for the incandescent lighting of the building, and run remarkably sweetly. Each set is capable of developing 75-horse power. This company also exhibits a number of interesting machine tools, some of which have self-contained electric motors. Two lathes, for instance, have motors boxed inside the fixed headstocks, and drive the gearing without any intermediate belting. The motors are designed in such a way that the speed of the lathe can be varied at will by altering the resistances in the field. A shaping machine for automatically cutting the teeth of bevel wheels to their correct shape, and a vertical profile milling machine, are both extremely cleverly designed tools. The latter is specially applicable for milling the ends of locomotive connecting-rods or for general copying work. The steel cutter spindle is mounted in a long cast iron socket, and runs in conical brass bushes. The upper bush is adjustable, and an end thrust bearing is provided. The spindle and socket are counterbalanced, and are capable of vertical adjustment. They are mounted in a carriage moving upon the face of a cross slide, adjustable slips and a pair of runners being provided to take the weight off the carriage and to reduce the friction of motion. The carriage is also provided with a reversible screw feed motion and a drag weight arrangement for use when working from a copy. The cutter spindle is driven by a four-speed cone fitted with internal double gearing, which can be readily disengaged. Upon the cone shaft is formed a long steel pinion which gears into spur and mitre wheels, with a vertical long pinion meshing with a spur wheel on the cutter spindle. This arrangement of driving reduces the friction of traversing the spindle carriage on the cross slide to a minimum. The table of the machine has a reversible feed motion, as well as a hand traverse, and has a circular table recessed into it. This circular table has also a self-acting feed motion in both directions as well as a hand motion, and will be found useful in milling circular work. This tool has its own electric motor mounted on an entablature at the rear, and the whole forms a most substantial piece of work. We described the leading features of Alfred Herbert's exhibits last week.

NEW CRUISERS FOR THE AMERICAN NAVY.

THE Navy Department has just received bids for the 3200-ton cruisers authorised by the last session of Congress. The same session of Congress also made provision for three battleships and three armoured cruisers, but because of the price-limit of five hundred dollars, a ton for armour, these vessels can neither be conclusively designed nor offered to the bidder till Congress made a more liberal allowance for Kruppised armour. Because of the absence of armour on these six cruisers, it has been possible to ask bids from the builders, and the awards will be made in the next few weeks, either upon the department's plans or those somewhat modified and offered by the builders.

By the Act of March 3rd last provision was made for six protected cruisers of about 2500 tons trial displacement, to be sheathed and coppered, and to have the highest speed compatible with good cruising qualities, great radius of action, and to carry the most powerful ordnance suited to vessels of their class, and to cost, exclusive of armament, not exceeding 1,141,800 dollars.

Bearing in mind that three out of the four successful bidders on the single-turreted monitors voluntarily offered to better the ships by doubling their turrets and increasing their displacement accordingly without extra cost, and that this proposition would have been accepted but for the refusal of the Connecticut's builders to join in, the Department designers have drawn more upon the Congressional price limit than the strict words of the Act demanded, and, instead of 2500-ton vessels, have called for 3200-ton ships for the same price. How much margin, even then, is allowed, can be gathered from the offer to build vessels of the required displacement, but of 18½ and 19 knots speed, and keep below the statutory limit by quite 41,000 dollars.

The Department's design has the following general dimensions and principal features:—

Length on load water-line	292ft.
Extreme beam	44ft.
Mean draught, estimated	15ft. 9in.
Displacement, ready for sea and normal coal supply,	3200 tons.
Estimated indicated horse-power	4700
Maximum speed, estimated	16½ knots.
Normal coal supply	467 tons.
Total bunker capacity	700 tons.
Load displacement	3443 tons.
Draught at load displacement	17ft. 3in.
Steaming radius of action, 10 knots	7000 knots.
Complement, officers, seamen, and marines	293.

The ships will be sheathed with wood from their wooden keel up to a minimum height of 2ft. above the water-line with 4in. Georgian-pine planking 9in. wide. This planking will then be coppered after the sheathing has been thoroughly caulked and the interstices filled with a mixture of red lead and white zinc under pressure. The greatest care will be taken to prevent galvanic action. A double bottom will reach nearly the entire length of the vessels. The protective deck will extend from bow to stern—being flat at the centre except near the forward and after parts, and at the sides, where it slopes sharply down below the water-line. The deck generally will consist of ¾in. plating, except on the slopes for a distance of about 105ft. in wake of the boilers and engines, where there will be 2in. nickel-steel armour plates 8ft. wide, thus covering the whole face of the slopes. Supplemental to the water-tight or protective deck, there will be a wide cofferdam along the whole water-line from stem to stern, which will be filled with fireproofed corn-pith cellulose. The disposition of the coal supply will also give added protection to the vitals. The fire main will be run below the water-line, risers leading therefrom to the principal compartments and decks, and each riser will be fitted with a shut-off valve at its outlet, and another near its junction with the main pipe. The main pipe will be connected to both steam and hand pumps.

The main deck—which, by the bye, is the only wooden deck, the others being covered with linoleum—reaches unbrokenly from bow to stern, and, besides adding to the structural stiffness, makes the vessels much drier below in bad weather, and yields a corresponding increase of berthing space for the crew. The wood in the main deck, like all of the rest to be used in the joiner work, will be fireproofed by an accepted process.

The use of wood has been restricted as far as possible, and light galvanised metal bulkheads will form the divisional work in the living spaces. The chart-house and captain's day cabin just abaft will be made of composition, and consequently will be non-magnetic.

In addition to the distilling plant having a daily output of 8000 gallons of potable water, there will be tank accommodation for a reserve supply of about 3000 gallons.

The ships will be fitted with all of the conveniences and facilities contributive to health and comfort characteristic of the service, and especial care will be taken to ensure ample ventilation for duty in the tropics.

The vessels are to be lighted throughout by electricity; there will be a set of Ardor's signals in the mainmast; and two large search-lights mounted on a stand up on the chart-house. Electricity will also be used to run the six ammunition hoists.

The ships will be rigged as fore-and-aft schooners, and will have a spread of something like 6000 square feet of canvas—enough to give them steerage way and to steady them in a seaway.

The motive power will be twin screws driven by triple-expansion engines. These engines will be of the four-cylinder type, each with a high-pressure cylinder of 18in., an intermediate-pressure cylinder of 29in., and two low-pressure cylinders of 35½in. respectively in diameter. The common stroke will be 30in. The collective indicated horse-power of the propelling and circulating pump engines will be quite 4700 when the main engines are making about 175 revolutions a minute, with a steam pressure of 275 lb. in the boilers, reduced to 250 lb. at the high-pressure cylinders.

The arrangement of cylinders, beginning forward, will be as follows:—Forward, low-pressure, high-pressure, intermediate-pressure, and after low-pressure. The forward low-pressure and high-pressure cranks will be opposite, also the intermediate and after low-pressure cranks, the second pair being at right angles with the first. The sequence of cranks will then be:—High-pressure, intermediate-pressure, forward low-pressure and after low-pressure.

The framing of the engines will consist of forged steel columns, trussed by forged steel stays. The engine bed-plates will be of forged steel supported on the keelson plates. Each engine will be in a separate water-tight compartment.

Steam will be supplied by six water-tube boilers, placed in two water-tight compartments. These boilers will have a total grate surface of at least 300 square feet, and a total heating surface of quite 13,000 square feet.

The smoke stacks will be 70ft. above the grate-bars, and, in addition, there will be fitted blowers for forced draught. With bunkers full, there is no reason whatever why the ships should not be able to cover the 7000 knots estimated at a cruising speed of ten knots an hour. There will be an engineer's workshop, which will be amply supplied with machine tools, enough to make all but extraordinary repairs of great magnitude. In the design the engineer-in-chief has looked particularly to the service for which the ships are specifically designed—that of mire work and place-time policing—and he has tried to make the motive power as economical as consistent with that of service. The armament of the vessels will be centred principally in the main battery of ten rapid-fire 5in. guns, of fifty calibres, and of the latest pattern. Two of these guns are to be mounted on the centre line—one forward, and one aft on the main deck—protected by cylindrical shields, where they will command a wide arc of fire.

The eight remaining 5in. guns are to be mounted in recessed ports, which permit the guns to be housed within the side-line. The two forward guns on each side can fire dead a-head, and then be swept aft through arcs of 150 deg. each. The four after guns have the same possibilities reversed. This gives a bow or a stern fire of five guns and a broadside of six. A supplemental fire of eight 6-pounders, two 1-pounders, and two Colt automatic guns is also provided. Six of the 6-pounders are mounted on the gun deck amidships, and way forward and way aft of the 5in. guns. The rest of the 6-pounders and the other smaller pieces are mounted on the hammock berthing in wake of the boats. A very liberal supply—153 tons—of ammunition has been provided for each vessel. There are no torpedo tubes.

Already these vessels have been pretty severely criticised by the technical Press of the United States. As the ships were primarily designed for mere police work, and especially for duty in the tropical waters of the West Indies and Central America, there is certainly no doubt but that smaller vessels could best answer the purpose of moral impression. Gunboats of the Yorktown type, of something like 1800 tons, and strictly modernised, would do the work economically and effectively, and a dozen of such craft could be built for the price of six of these new cruisers. As has been said already, the increase from 2500 to 3200 tons was brought about through the department's desire to get its money's worth this time; but there seems to be a growing belief that it is getting more than the service for which they are designed calls for, while having just that much more ship to be kept in fighting trim for no real offensive equivalent in return when hostilities come. The New Orleans has been the structural inspiration for these cruisers. The Chattanooga, one of these vessels, is illustrated on page 520.

GRIEVANCES OF YOUNG ENGINEERS.

PROFESSOR EWING voiced the grievances of many young engineers at a meeting held in the Senate House, at Cambridge, on Saturday afternoon, under the presidency of the Vice-Chancellor, to form an Association for the employment of graduates of the University in the various professions and occupations for which they were fitted by their University training. He said they had an extraordinarily copious supply of men in the engineering department of the University. Year by year and term by term the stream of young men coming up to learn engineering continued to be increased. They endeavoured, with the very scanty resources at their disposal, to give these young men such a training as might be helpful to them in their professional life, and here, it might be said, that their responsibility ended. Still they could not see, without some sad anxiety, that little army, year by year swelling in numbers, going down after taking their degrees, facing in its simplicity the entirely unknown world of practice. And, again, they could not help feeling that it would be well if the employers were aware what a large volume of excellent material was at their hands, only lacking a little practical experience to make it of first-rate utility. He thought an Appointments' Association would do much to foster both these ends. The young engineer when he left the University had to get some practical experience. He was sorry to say that generally he had to pay dearly for it; he had to pay for the privilege of giving his services gratuitously to his first employer often for three or four years. One thing the Association might very well set itself to do, and that was to endeavour to secure at the hands of engineers some better, some more reasonable terms, for the reception of young men into their works. He would like to see more in England of what they constantly saw in America—a graduate from the technical school being at once accepted as at least worth his bread and butter.

Then, again, in the history of a young engineer, after this period of probation was passed, it often happened that he found himself entirely adrift. It was then, he hoped, he would again turn to the Association—he had probably kept his name on the books—and would look to it once more, as he would look to a qualified registry office, to put him in touch with an employer who wanted practical experience as well as scientific training. One often received letters of inquiry from employers, saying that they wanted a man, with a scientific training and practical experience, for such and such a post. Within the last week it had fallen to his lot to answer three such letters. With the best will in the world to find places for young men, it was by no means easy to answer such letters. The young man who answered the specified requirements had gone down two or three terms ago; one had lost touch with him; one did not know whether he wanted a place, and so it often happened that such letters had to go without any satisfactory response. All these were matters for this new Association. He thought employers would go to the Association, knowing that it would act the part of an honest broker, and that the men whom it recognised would at least have shown some guarantee of their qualities, some capacity for discharging the work that they were trained to do; and as regarded the engineer employers in particular, he thought they would turn their eyes more to the University than they had done in the past, they would do so to an increasing extent, and they would soon learn that men who came from the University with a sound scientific training made good engineers.

It was unanimously agreed, on the motion of Lord Rothschild, to form a University Appointment Association, and a strong board of management was appointed. Among those who wrote expressing sympathy with the objects of the movement were: Lord Loch, Sir John Lubbock, Mr. Hugh Bell, Messrs. Bell Bros., ironmongers, North of England, Mr. Yarrow, Sir Thomas Andrews, Mr. W. H. Allen, Queen's Engineering Works, Bedford, Mr. Noble, Britannia Works, Ilford, Mr. Kennie B. Murray, secretary of the London Chamber of Commerce, and many others.

THE NEW BATTLESHIP ALBEMARLE.

IN a late issue—October 13th—we noted as under construction, both as regards the vessels and their propelling machinery, by the lately re-constituted Thames Ironworks Shipbuilding and Engineering Company, Limited, of Blackwall, two battleships of the Duncan class, named the Duncan and Cornwallis; and in our issue of November 10th we very briefly mentioned the launch, at Chatham dockyard on the previous Thursday, of her Majesty's battleship Venerable.

The last-mentioned ship was only laid down in the first week of last January, and her construction was proceeded with at such a pace as to enable her to be put into the water in exactly ten months from the day on which her first keel-plate was laid. This record rate of building was proceeded with so as to enable a further new battleship of the Duncan class to be laid down on the slip which the Venerable was then occupying. Preparations are now being rapidly made at this slip for the building of the new vessel, to be named the Albemarle, which will be of the same general dimensions as the Duncan and Cornwallis, or 5ft. longer than the Venerable, but of 1000 tons less displacement than that vessel.

The order for the supply of the propelling machinery of this new battleship has been placed with the Thames Ironworks Company, and it will be carried out at their Thames Engineering Works—late John Penn and Sons—at Greenwich. It will be of 18,000 indicated horse-power, and will consist of two independent sets of four-cylinder triple-expansion engines; each set driving a four-bladed 17ft. diameter bronze propeller; steam being supplied by twenty-four Belleville water-tube boilers, each fitted with economisers, and worked at a pressure of 300 lb. per square inch.

The estimated speed of the new battleship in smooth water, and under natural draught to her boiler fires, is to be the same as her sister ships of the Duncan class, viz., 19 knots an hour; and she will have similar coal bunker capacity, or 900 tons at her load draught with provision for carrying 1000 tons additional.

A NEW ACCUMULATOR.—A new method of accumulator construction has been devised in Germany. It resembles that used in the original Volta pile, the cells being piled one above the other. The battery consists of a series of shallow rectangular lead vessels with sloping sides, placed one above the other, with spherical insulators in the four corners of each vessel to prevent metallic contact. The bottom of each vessel is corrugated. From the crests of the corrugations project inwards the negative plates, while the positive plates are suspended from the lower or outer face of the corrugated bottom. When the vessels are in position the downwardly projecting positives of any cell come between the upwardly projecting negatives of the vessel immediately below it.

THE ARMOURED TRAINS.—It is interesting to note that on several of the armoured trains which are being used for the conveyance of troops against the Boers in South Africa there is a steam pump attached to the locomotive. The pump is of Merryweathers' "Valliant" pattern, and takes its steam from the locomotive boiler. Sufficient hose is carried to enable water to be pumped from any stream or other source passed on the way, the water being stored in a tank carried on one of the trucks, and available for boiler feeding or drinking purposes. It will be remembered that during the Soudan campaigns steam pumping engines of this type were employed to supply the camps with water. Each pump delivers 1200 gallons per hour, and will deliver that quantity through even three or four miles of hose. In the case of the Soudan several were used, one pumping from the supply to a point three or four miles away, when another pumped the water a similar distance forward.

RAILWAY MATTERS.

It is expected that the electric tramways will come into use in Bolton early in January next.

The Compagnie Générale de Traction, which owns sixty miles of line in Paris, will eventually equip the whole of it on the Diatto electrical traction system.

The construction has been sanctioned at the cost of the Jhind and Maler Kotla States, of a broad-gauge railway from Ludhiana, *viâ* Dhuri, to Jakhal, about eighty miles in length.

The London, Brighton, and South Coast Railway Company has decided to put on seven additional workmen's train from East Dulwich and Peckham stations, and to reduce the fares by one penny.

The Empire state express was delayed one day recently, and in the endeavour to make up time, the run of the 150 miles between Syracuse and Buffalo in 140 minutes is said to have been made.

There is a rumour that an electric railway, 180 miles long, is to be constructed in Kashmir. Water power will be used for generating the electricity, and the power available is said to be 100,000-horse power.

A new type of electric railway car is being used in Brussels the object of which is to reduce air resistance. The front of the car is triangular in shape, the controller and motorman being stationed in the angle.

The London County Council will seek powers next session, for the reconstruction for electrical traction of the portions of the tramways between Westminster Bridge-road and Tooting, and between Blackfriar's Bridge and Kennington. The estimated cost of the reconstruction of these lines is about £251,000.

A scheme is now before the town authorities of Folkestone for the provision of electric tramways through many of the streets, and connecting with Hythe and Sandgate. The scheme is that of a company, however, and there is a strong opinion that the Corporation should undertake the scheme.

Application is about to be made to Parliament for powers to construct what would be known as the Leeds City and Suburban Railway. The route to be traversed is from Hunslet to Shadwell, a distance of 7½ miles. The proposed line forms a junction both with the North-Eastern and the Great Northern railways at Hunslet.

A syndicate has been formed to construct an electric railway between Rotterdam, the Hague, and Scheveningen. The line will be double track throughout, and will be connected with the ordinary steam service at Rotterdam. A junction will be effected with the State railways at the Hague; a speed of 50 kilometres (31 miles) per hour is proposed.

A rail-joint hydraulic press is being introduced in America for the purpose of driving the splice bars home to a good bearing on the rail while the bolts are being put in, thus preventing trouble from the lack of tightness in new joints. The machine is especially intended for the deep heavy splice bars of street railway girder rails, some of which have twelve bolts, in two rows.

The Government of India have called upon the agents and managers of Indian railways to favour them with their views on the desirability of establishing a scheme for training soldiers as station-masters, drivers, firemen, guards, and the like, with a view to forming a reserve of men instructed in railway work, whose services might be available in case of emergency.

The North-Eastern Railway Company is about to apply to Parliament for powers to construct a line commencing by a junction with the York and Harrogate Railway, in the parish of Knaresborough, and terminating by a junction with the Church Fenton and Harrogate Railway, in the parish of Kirk Deighton, and to widen the York and Normanton and Leeds and Selby Railways.

Henceforth a hundred working hours in ten days is to be the maximum exacted of any railway employé in France, and no consecutive stretch of more than twelve hours is to be tolerated. This important reform will come into operation all over France in the course of the next two months, and, besides being an immense boon to the railway servants, should be productive of beneficial results to the public.

The directors of the Bombay, Baroda, and Central India Railway will propose, at the meeting to be held in December next, the payment of a dividend in January next on the consolidated stock of the company of £1 13s. per cent. in addition to the guaranteed interest, making in all a distribution of £4 3s. per cent. for the half-year, less English income tax, as against a distribution of £4 12s. 6d. for the corresponding period of last year.

Electric tramways in the United States now produce nearly as large an income as the steam railroads. The total invested capital in the street railway systems of the United States is estimated at £350,000,000. The annual income is estimated at £35,000,000, while the annual income of the steam railroads is estimated at £54,000,000. The electric street railroads carry 5000 million passengers annually, or ten times as many as the steam railroads.

The North-Western Elevated Railroad Company in Chicago has ordered 150,000 lb. of aluminium, to be used as feed wires on its road. Three sizes of aluminium cable will be used, the largest being about 1½in. in diameter. The feeders will be placed in a wooden box or trough, and will be supported on vitrified clay blocks, about 9ft. apart. The estimate is that 47 lb. of aluminium wire will answer the same purpose, electrically, as 100 lb. of copper wire.

The Government of India have before them the estimate for the construction of the extension of the Nilgiri Railway from Coonoor to Ootacamund, amounting to Rs. 19¼ lakhs. The delay in the construction of the line is said to be due to the refusal of the Government to sanction the proposal of the Nilgiri Railway Company that Government should give a direct guarantee of net earnings on the entire capital outlay required for the whole line from Mettapollium to Ootacamund.

It is probable, says a contemporary, that the railway parliamentary Bills deposited during the present month will include one for a scheme for further developing the Great Central Railway as a route to the north-east of England and Scotland. The construction of a short section of new railway—only about five miles—in the neighbourhood of Sheffield will be necessary, but this would have the effect of bringing the Great Central's London line into direct connection with the North-Eastern system, *viâ* Woodhouse, Rotherham, Swinton, and Knottingley.

Lieut.-Colonel Yorke's report to the Board of Trade on the collision that occurred at 6.8 a.m. on the 19th of September at Perth General Railway Station, between two trains of the Caledonian Railway Company, has been issued. The inspector states that while the 8.0 p.m. tourist train from Euston was standing at the down main line platform in Perth Station, it was run into in the rear by the 4.20 a.m. train from Glasgow, owing to the driver of the latter, which had been admitted to the same platform, not having his train under sufficient control. Colonel Yorke says the collision, the consequences of which were fortunately less serious than might have been expected, was manifestly due to the want of care and high speed with which the driver, John Russell, permitted his train to enter Perth Station, and he regarded him as responsible for the collision.

NOTES AND MEMORANDA.

Telephonic communication between St. Petersburg and Moscow is obtained by a line 412 miles long. It is said to be the longest single line in Europe.

The telegraph line from Lake Bennett to Dawson City is in good working order, and in favourable circumstances telegrams can now reach there in four days, including the time required for conveyance of the messages from Vancouver to Skagway by steamer.

The Narragansett Electric Light Company, of Providence, R.I., is installing a three-wire distributing system with 450 volts between the outer conductors and 225 volts between each outer and the neutral. This is only the second system of the kind in the United States.

An American electrical journal reports that insulators are made as follows:—Maine granite is crushed and moulded into form and fused at 3000 deg. Fah.; 56,600 volts were required to pierce ¼in. of this material in the shape of cup insulators. We should like to see this process.

We hear that at the Yale Observatory eight cameras were prepared for the purpose of photographing the meteors of the expected Lenoid shower on the nights of November 14th and 15th. We are very much afraid that the authorities must have had a great deal of trouble for nothing.

In planning drainage schemes provision should be made for removing rainfall per hour as follows:—From roofs—measured horizontally—·5in. in depth; from flagged surfaces, ·2in. in depth; from paved surfaces ·10in. in depth; from gravelled ·05in. in depth; from meadows or grass plots, ·02in. in depth.

We hear M. Vallot, the director of the observatory on Mont Blanc, has been considering the advisability of installing the Marconi wireless telegraphy system upon the mountain. The ordinary system of telegraphy is used normally, but the great snow-drifts have played havoc with the telegraph wires.

The production of sulphur in Sicily amounted to 3,000,000 tons in 1897, which grew to 3,200,000 tons in 1898. In 1893 the principal buyers were the United States, 142,553 tons; France, 95,000 tons; continental Italy, 60,919 tons; Germany, about 27,000 tons; and Great Britain, with Malta, only 26,487 tons.

Glass plate cast with wire gauze inclosed in its substance, submitted to tests in Vienna, have been found to possess great consistency as well as resistance to pressure, shock, and the effect of heat, the resistance being 361 lb. per square inch, and the consistency 3610 lb. per square inch of the transverse sectional area.

It has been discovered that the lead-covered electric wires at the official residence of the Lieutenant-Governor of Bengal, Calcutta, have deteriorated most seriously. A large part of them may have to be renewed shortly, though it is only about three years since they were put in. We understand that they were buried in the plaster.

The St. Louis and St. Paul, New York and Paris, can steam at four knots with the main throttle shut, by the use of the exhaust steam of the auxiliary engines only. About 30 tons per day is the necessary consumption for auxiliaries, and the exhaust steam is sufficient to propel the ship at four knots and keep the machinery ready for immediate increase of speed to 20 knots.

The value of the gold obtained by dredging in New Zealand for the twelve months ending March 31st last amounted to £169,689, which was 61·4 per cent. of the value of the alluvial gold, and 14·5 per cent. of the value of the gold exported from the Colony. Material can now be dredged, washed, and the stones and tailings elevated and conveyed clear of the pontoons at a cost of from 1d. to 3d. per cubic yard.

It is said that Dr. Ludwig Mach has successfully alloyed aluminium with magnesium, and thereby obtained a compound which can be worked like brass, and which is lighter than aluminium. A 10 per cent. magnesium alloy resembles zinc, a 15 per cent. alloy is like brass, and a 25 per cent. like a compound bronze. It is stated that the alloys can be soldered, and that they keep well in dry and damp air, and give good castings.

A thermostat has been designed in America to give warning of spontaneous combustion in coal pockets. A compound solder-release thermostat, encased and protected by iron pipe, is placed in the centre of every 10ft. cube of coal, both horizontally and vertically. The thermostat has two operating points, one at 155 deg., the other at 286 deg., and as these two points are reached bells are rung and warning given of an approaching fire.

It is estimated that the total make of pig iron in Russia during 1900 will be 163,000,000 poods—about 2,700,000 metric tons. This will be an increase of some 500,000 tons over 1898. The Moscow district, it is estimated, will show an increase from 11,000,000 poods last year to 16,000,000, a gain of 45·5 per cent. The smallest growth is in the Oural district, where the estimated increase this year is 4,500,000 poods, or 10·3 per cent.

The armoured cruiser forming part of the French naval programme for 1900 is intended to displace 12,416 tons, with a length of 475ft. 9in.; beam, 71ft. 2in.; draught, 26ft. 3in.; armament, four 7·6in., sixteen 6·4in. two 1·8in., and four 1·4in., and five torpedo tubes, of which two are submerged; vertical triple-expansion engines of 24,000 indicated horse-power, supplied by water-tube boilers, driving three screws and giving a speed of twenty-one knots; coal capacity, 1350 tons; complement, 23 officers and 687 men.

The following are the particulars of the two new battleships to be built in France next year:—Displacement, 14,865 tons; length, 439ft.; beam, 78ft. 9in.; stern draught, 27ft. 6in.; armament, four 12in. breechloaders, 18 6·4in., 26 1·8in., and two 1·4in. quick-firers, and five torpedo tubes, of which two are submerged; vertical triple-expansion engines of 17,475 indicated horse-power, supplied by water-tube boilers and driving three screws, to give a speed of 18 knots; normal coal capacity, 905 tons; extreme, 1825 tons; complement, 42 officers and 780 men.

In order to investigate the effect of variations of torsion upon the electrical resistance of wires, it is necessary to eliminate the effects of temperature changes. As this is rather difficult M. C. de Szily experimented with constantan, an alloy which has a temperature coefficient that can be neglected. The results of a great many experiments given in *Comptes Rendus* show that the electrical resistance augments as the angle of torsion increases. Up to the elastic limit of the metal, the variation appears to be directly proportional to the angle of torsion. But beyond the elastic limit of the metal, the resistance varies more rapidly than the torsion.

Some useful figures relating to the influence of temperature on the strength of wrought iron appeared recently in an American contemporary. The tensile strength of wrought iron or steel appears to be a minimum at about 70 deg. Fah., and increases as the temperature is changed in either direction, becoming about 20 per cent. greater at about 500 deg. Fah. and at 60 deg. below zero. There are indications of a brittle region at the temperature of steam at 5 lb. to 10 lb. pressure. Iron at low temperatures, while increasing in strength, retains its ductility. In the case of cast iron the tensile strength remains constant from 70 deg. Fah. to 700 deg., decreasing from that point to zero at 1240 deg.

MISCELLANEA.

Telegraphic communication has been opened up with the Dartmoor village of Manaton.

It is stated that the destroyer Viper, fitted with Parson's steam turbines, has attained a speed of 37 knots on the measured mile.

The town bridge at Northwich, over the river Weaver, which was opened last week, is one of the few bridges in this country operated electrically.

On the basis of results of previous exhibitions at Paris, it is expected that 52,588,280 people will pass through the turnstiles, and it is thought possible that the total number may reach 60,000,000.

From the North we hear that two large electrical power supply schemes are to be brought before Parliament during the ensuing session. These are the Tyne-side Electric Power Supply and the County of Durham Electric Power Supply. Both will embrace large areas.

There is no import duty on coal in Germany. The water freight rate for coal on whole ship cargoes from Rotterdam to Frankfort varies from 2½ to 3½ marks per metric ton to 4 to 5 marks or even higher. For the transfer of coal from ocean vessels to river barges at Rotterdam the lowest rate is 35 pfennigs per ton.

The report by Sir William Crookes, F.R.S., and Professor Dewar, F.R.S., on the composition and quality of daily samples of the water supplied to London for October, says the chemical and bacteriological analyses for the month show that the supply of water to the metropolis continues to be highly satisfactory.

A significant fact in the Pennsylvania iron trade is that the Thomas Iron Company, Catasauqua, has just received an immense consignment of ore, said to have been over 300,000 tons, from Nova Scotia. The company has of late been taking native ores from the Lehigh Valley. The foreign ore is to be used at Catasauqua and Alburtis.

The water supply of Havana is collected from springs at the base of a range of coral hills, and carried through a masonry aqueduct 33,000ft. long to a reservoir holding 21,000,000 gallons. The consumption and waste of water in the city is estimated at 173 American gallons per head daily. The city is supplied by gravity from the reservoir.

It is stated that the greatest trouble with the pneumatic tire on heavy vehicles is not caused by puncturing, which accounts for only about seven per cent. of the trouble, but results from the internal wear of the fibres of the tire, due to the weight. Some tires which have been examined show the fibres of the material reduced to a fine powder.

The Salt Lake is said to be receding on account of the excessive drain made upon it by irrigation enterprises. The lake is fed by the Jordan and other rivers, and when the water of these streams is intercepted for irrigation purposes the water supply of the Salt Lake is, of course, diminished. In time it looks as if the lake will be only a bed of dry salt.

The Admiralty authorities have just placed orders at Cardiff for about 150,000 tons of best Welsh steam coal. The price ranges from 18s. to 19s. net. The order has been divided as follows:—Cambrian Colliery, 20,000 tons; Cyfarthfa Collieries, 5000; Locket's Merthyr Collieries, 6000; Ocean Colliery, 20,000; Nixon's Colliery, 20,000; Ferndale Colliery, 5000; Insole's Merthyr Colliery, 40,000; National Colliery, 20,000; Ynisfeio Colliery, 30,000.

It is stated that the new cable from Germany to the United States will probably be open to the public in April, 1900. It is expected that the cable station at Fayal in the Azores will then be ready. The German Atlantic Telegraph Company is to lay and work the new cable from Emden to New York *viâ* the Azores, and will supply in the future any cables that may be required especially for the German Government, and for the various German telegraph companies.

On the 11th inst. a monster blast was successfully fired at the granite quarries belonging to Gardner and Co., near Bonarve, on the shores of Loch Etive, Argyllshire. Fully five tons of gunpowder were used in two chambers, the quarrying of which, and the passage leading to them, occupied about eleven months. The charge was fired by electricity, and the granite, to the extent of thousands of tons, was slowly upheaved and slid down to the quarry floor.

The tunnel made under the Spree for the passage of the tramway line between Stranlau and Treptow, Berlin, was opened for traffic on September 16th. It measures 496 yards in length, of which 213 yards are under the river itself. Its diameter is 4·37 yards. The lowest point of the ground of the tunnel is 12·40 yards under the mean level of the water in the river. The tunnel was executed in about two years and a-half, and cost £85,000, or about £170 per yard.

The Derwent Water Board, constituted to divide the water of the Derwent and the Ashop between Leicester, Sheffield, Derby, and Nottingham—the combined cost of the schemes being over six and a-half millions sterling—held its first meeting last week. Mr. Alderman Gainsford, of Sheffield, was appointed chairman; Mr. Alderman Wood, of Leicester, vice-chairman; Sir Henry Bemrose, of Derby, treasurer; Sir Henry Johnson, of Nottingham, standing arbitrator; and Mr. Bell, town clerk of Leicester, clerk.

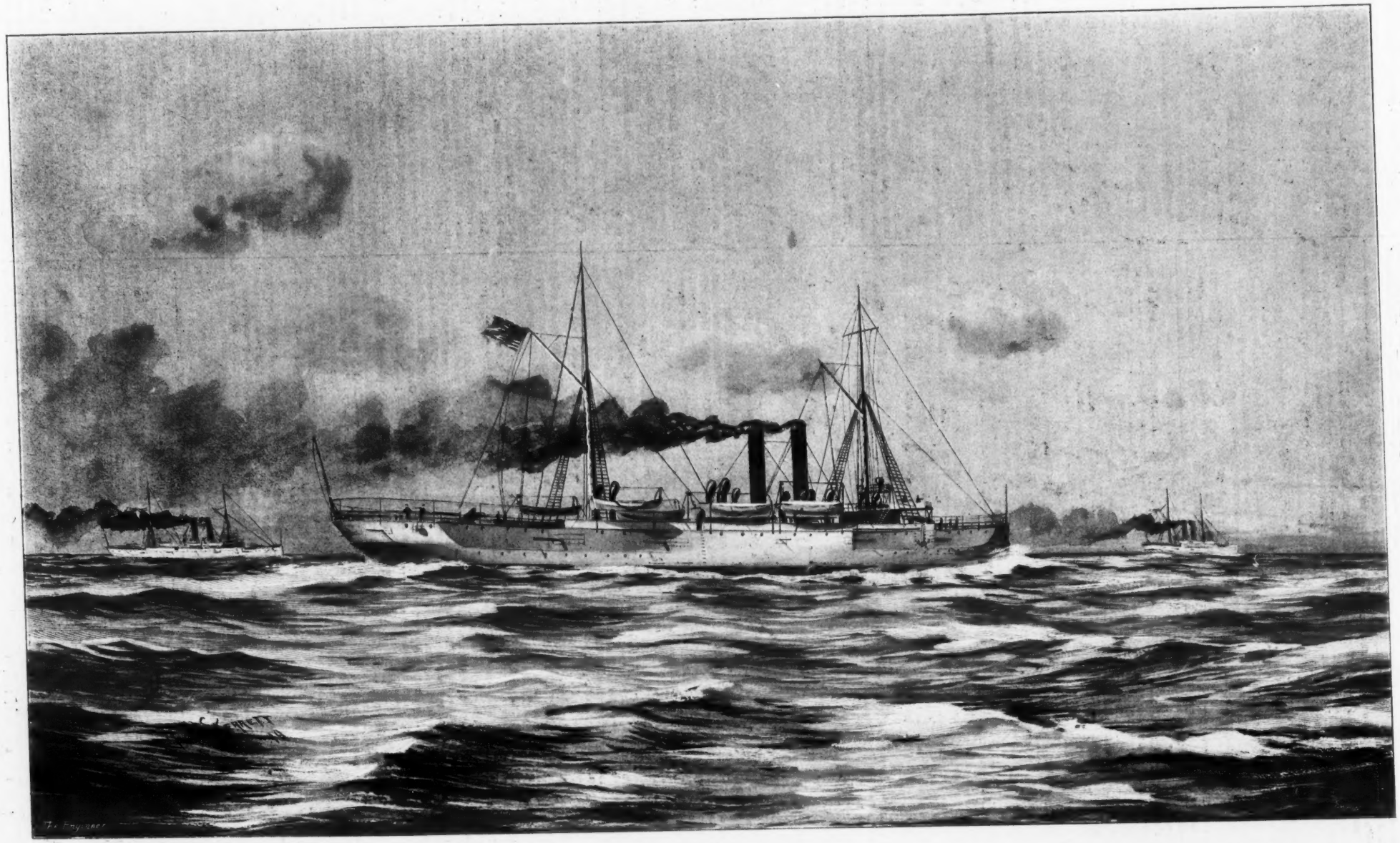
There are now three Scherzer bascule bridges across the Chicago River, one being a four-track railway bridge, while the others are highway bridges. Two other bridges of this type are now to be erected, to replace old swing bridges whose centre piers are to be removed in order to give the river the necessary capacity of flow required for the Chicago drainage canal. The bridges will give a clear channel of 120ft. between the guard piles, measured at right angles, and the river will have the required capacity of 300,000 cubic feet per minute.

The war in South Africa has given a considerable impetus to the bedstead trade. During last week the War-office placed contracts for several thousands of hospital bedsteads. Firms who have been fortunate enough to obtain the orders, which were required to be delivered at very short notice, have kept their factories running almost day and night. In view of the urgency of the situation, the War-office accepted the bedsteads in varying patterns. A further advance in the price of iron and mixed iron and brass bedsteads of 15 per cent. will come into operation on February 1st, 1900.

It seems that after all the engineers have had something to do with getting the naval guns to work at Ladysmith. In the *Army and Navy Gazette* for November 18th the following passage occurs in a leading article:—"Captain Scott worked out his scheme for the carriage with the assistance of Mr. F. J. Roskruge, assistant engineer, and Lieut. F. C. A. Ogilvy, of the Terrible. Lieut. Ogilvy superintended the portion upon which the carpenters were at work, while Mr. Roskruge made the drawings and attended to the construction of the metal portions, allowing for all strain and recoil. The carriage was designed, the parts made and built, and the gun mounted in position in less than forty-eight hours. It was afterwards tested and found to be all that was necessary."

UNITED STATES CRUISERS CHATTANOOGA CLASS

(*For description see page* 518)



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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

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TO CORRESPONDENTS.

**** In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

**** All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. S. V. B.—So far as we can see, your boiler is like the De Dion. Numerous boilers have been made fed with fuel at the top. There is nothing new in the principle, but, of course, patents can always be secured for arrangements of details. Whether the patents when obtained are of any value is quite another matter.

Cuban Iron Ore.—In the leading article on this subject which appeared in our last impression, there is given a quotation from the *Boston Herald*. We have not directed attention to an error in the calculation, which has, however, probably been detected long since by our readers. The error in question is that Spanish ore can be laid down in Boston for 3 dols. per ton. The mistake lies in the implication that ore can be had in Bilbao for 1·2 dols. per ton; the real price at present being about 3·2 dols. per ton.

Winter.—It is impossible without diagrams to calculate the indicated power of an engine. A rough rule is to proceed as if there was only one cylinder, the low pressure, and the total range of expansion and initial pressure being known, to calculate the average pressure by adding 1 to the hyp. log. of the ratio of expansion, multiplying by the initial pressure, and dividing by the ratio of expansion. Thus let the initial pressure be 100 lb. absolute, and the ratio of expansion 12 to 1.

The hyp. log. of this is 2·48, and $\frac{1 + 2{\cdot}48 \times 100}{12} = 29$ lb., which is the average absolute pressure. But all these calculations give only approximations to the actual fact.

INQUIRIES.

CARPET PRESSES.

Sir,—We shall be obliged to any of your readers who can give us the address of makers of carpet baling presses.

London, November 16th. T. and Co.

MEETINGS NEXT WEEK.

Liverpool Engineering Society.—Wednesday, November 29th, at 8 p.m. Paper, "Fire Risks of Electrical Installations," by Mr. A. Lester Taylor.

The Institution of Junior Engineers.—Friday, December 1st, at 8 p.m., at the Westminster Palace Hotel, Victoria street. Paper to be read and discussed, "Natural Methods for the Purification of Water-carried Sewage," by Mr. G. Drysdale Sweetman, Member, of Ryde.—Saturday, December 2nd, Visit the Sewage Disposal Works of the Sutton Urban District Council.

Society of Arts.—Monday, November 27th, at 8 p.m. Cantor Lectures. Four Lectures on "Enamelling upon Metals," by Mr. Henry Hardinge Cunynghame. Lecture II.: Method of executing Limoges enamels—Preparation of the metal plate, of the enamels—The firing paillons.—Wednesday, November 29th, at 8 p.m., Ordinary Meeting. Paper, "The Great Seals of England," by Mr. Allan Wyon.

The Institution of Civil Engineers.—Tuesday, November 28th, at 8 p.m. Papers to be discussed, "The Waterloo and City Railway," by Mr. H. H. Dalrymple-Hay, M. Inst. C.E.; "The Electrical Equipment of the Waterloo and City Railway," by Mr. Bernard M. Jenkin, Assoc. M. Inst. C.E. Paper to be read, "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc. M. Inst. C.E.—Thursday, November 30th, at 8 p.m., Students' Meeting. Paper, "Bridges for Light Railways," by Mr. L. H. Rugg, Stud. Inst. C.E.

THE ENGINEER.

NOVEMBER 24, 1899.

LOCOMOTIVE ENGINES AND SMOKE.

It appears to be certain that on the 28th of July last the Public Control Committee of the London County Council reported that their attention had again been called to "the very serious nuisance from smoke discharged from railway locomotives on the various railways entering London." The report then goes on to say:—"We are satisfied that locomotives are generally so constructed as to be able to consume their own smoke, provided proper fuel is used and that proper care is taken in stoking. The use of proper fuel doubtless entails some extra expense to the railway companies, and proper stoking unquestionably adds to the labour of the firemen in charge of the furnace." Next the means of abating the nuisance are discussed. The Committee point out that proceedings under the Public Health Act would be tedious, difficult, and probably abortive, and conclude with the following recommendation:—"That the Public Control Committee be authorised to take the necessary steps for enforcing in the county of London, Section 114 of the Railway Clauses Consolidation Act, 1845, which requires that every locomotive shall be constructed to consume its own smoke, and Section 19 of the Regulation of Railways Act, 1868, which provides that if a locomotive is constructed to consume its own smoke, but fails to do so as far as practicable at the time charged in the complaint, the railway company owning such locomotive shall be deemed guilty of an offence against the section first named."

We are the last to suggest that locomotive engines should be permitted to discharge smoke into the atmosphere of London, or indeed any other town; nor should we regard with pleasure a locomotive discharging smoke under any circumstances whatever, but we none the less pronounce the report from which we have quoted as wholly unnecessary. The London County Council cannot be more anxious than are the locomotive superintendents of this country to prevent the evolution of smoke; and, we think, it may be taken for granted that they leave nothing undone to prevent it. Within the last few weeks we have made careful inquiries, and find that the London County Council appear to have taken but limited action in the matter. With the London and North-Western, Great Western, Great Northern, Midland, and South-Western, they have not interfered. The Great Eastern Railway, however, has been warned, and a copy of the report from which we have quoted has been sent to the company. The London and Brighton Company has, moreover, been attacked several times in the Greenwich Police-court, with success for the defence as a rule. There is some reason to believe that the London County Council may at any time take energetic action, and the case for and against the locomotive will then be thrashed out as it has never been thrashed out before. The fight will be one which will enlist a whole army of experts to give evidence; and there will certainly be no want of funds on either side to carry on the war. Such a waste of money would be deplorable, and may, we think, be entirely avoided if due weight is given to facts and conditions which may be simply stated. If it can be shown that it is not possible to do more than is being done to prevent the evolution of smoke, then the prosecution must fall to the ground. Carbonic acid and carbonic oxide, and sulphurous acid—to give the gases their vernacular titles—are far more unwholesome and inimical to life than soot; yet no matter how perfect the combustion of the fuel these gases are given off. But no action could lie against the railway companies, not only because the Acts of Parliament, in a sense, give exemption, but because a successful prosecution would end in the stoppage of all railway traffic carried on by steam locomotives. The questions at issue, then, are two in number. In the first place, is the modern locomotive constructed to "consume its own smoke," and assuming that it is, is it worked carefully to secure that end?

Now, the first question is one which admits of being fought out on very wide issues. A few facts of some importance can be brought to bear on it. One of these is that for about a century engineers have been wrestling with the smoke-nuisance problem. The net result is that non-bituminous coal, such as Welsh, can be burned with very little evolution of smoke, under almost any circumstances—although the coal is by no means smokeless like coke or true anthracite—and that bituminous coal can be burned without smoke under special circumstances only. The conditions are extreme uniformity in the demand for steam, plenty of combustion room, and very moderate rates of combustion. All attempts made to combine smoke prevention with forcing the fires have been attended by the rapid destruction of some part of the boiler. For example, when air is introduced at or about the bridge of an internally-fired boiler, the injury of the crown plates has usually followed. Under the most favourable circumstances great vigilance is required to prevent smoke. The largest measure of success has been obtained with such devices as Juke's travelling grates. But all these things are inapplicable to locomotives. Many thousands of pounds have been expended in this country, the United States, and Europe generally, in experimenting with furnaces suitable for locomotive boilers. A reasonable amount of success has been attained. It has been found that the balance of advantages rests with the rectangular fire-box with a brick arch, and a scoop deflector in the fire-door. Sufficient air is admitted through the bars to cause the evolution of gas from the fuel, and this gas is then supplied with air through the fire-door to complete its combustion. Hundreds of devices have been tried for injecting and mixing air with the flames; but none of these appear, on the whole, to give more satisfactory results than the normal scoop deflector. It is generally known that locomotive engines hauling trains in the country give off very little smoke, no matter what the kind of coal burned. This statement seems to be contradicted by photographs often published, showing trains running at full speed and pouring out torrents of black smoke; but this effect is purposely produced. The driver and fireman know beforehand within half a mile or so of where the photographer will take his stand; and a few shovelsfull of coal carefully spread on the top of the fire, and a closed fire-door, to say nothing of a momentary shutting off of steam, perhaps, will give all the smoke that the artistic soul of the photographer can desire. But this in no way represents the normal working of the furnace. It is not with such trains that trouble is incurred, but with the local or suburban trains, and for these there is only one efficient way of entirely preventing smoke, that is to burn coke or the very best Welsh smokeless coal.

We are brought here in contact with a set of conditions which are unfavourable to the prevention of smoke. That can only be effected when the rate of combustion is uniform, the admission of air constant, and the firing very regular. But none of these conditions obtain with the suburban locomotive. It has to stop every mile or so—on some lines even more frequently. It has to get up speed as quickly as possible, and to that end is run with little expansion. The furnace is the scene of a furious draught and intense combustion at one moment, and the next the supply of air falls to little or nothing, just at the time when gas is being given off most rapidly. With bituminous coal it is practically impossible to prevent the evolution of some smoke under such conditions. The most that can be hoped for is its mitigation. In the country firing is prohibited in stations, and as little as possible is to be done on those parts of the road passing through towns; but this rule cannot be observed on suburban lines. The coal must be put into the fire-box somewhere, and there is never a sufficient interval between two stations to permit the charge to reach thorough incandescence. The result is that if the engine does not smoke in one place it will in another. We have never yet seen any satisfactory way out of the difficulty; that is to say, if the engine is to make enough steam—and it should not be forgotten that suburban engines are often very hard worked. Take, for example, the high-level line from Victoria to the Crystal Palace. The low-level line of the Brighton Company from Victoria is very heavy. There is a tremendous pull again up from Farringdon-street to Ludgate-hill, and it is not remarkable that an engine which has just hauled thirteen or fourteen coaches up 1 in 34 entering Ludgate-hill Station should be found to give off a little smoke. It is useless to theorise on the matter. If suburban traffic is to be worked as the London County Council would have it, then nothing can be used but coke, oil, or smokeless steam coal.

Here we come to the vital factor in the whole question.

For months past, and for months to come, coke will be wholly unattainable. Even if gas coke could be had, steam could not be kept with it—it is too poor a fuel. Special Welsh coal has for a long time been scarce and dear; it is now scarcer and dearer than ever. In fact, it cannot be obtained at all in sufficient quantities to satisfy the demands of the railway companies. Under the circumstances resort must be had to the next best available—ordinary steam coal. We are quite certain that everything that can be done will be done to prevent the evolution of smoke, and nothing will be gained by harassing tactics on the part of the London County Council. It is not at all improbable, however, that a little smoke will be given off, but it will be very easy for the railway companies to prove that they have done all that they can do to prevent it. Let it be borne in mind that for the suburban locomotive an adequate supply of fuel of the right kind is essential. If lawsuits occur, we are certain to hear of this, that, and the other invention which will prevent the production of smoke. Each and all of these inventions may be quite right. Nevertheless, it may be taken as absolutely certain that no invention exists which will enable a steam locomotive to work suburban traffic without some evolution of smoke from bituminous coal. In a word, whether the engine does or does not give off smoke depends on the kind of coal burned, and so a prosecution by the County Council may be stated at once as an attempt to define with precision what kind of coal a railway company must not burn.

OUR GUNS AT LADYSMITH.

Our navy has proved good, as seen at Ladysmith. We were taken rather at a disadvantage in the fact that the forces in Ladysmith were called upon to sustain a regular siege in which fairly heavy siege guns were brought up against us, while we had for our defence only field pieces. Ordinarily, the besieged have, if not heavier, at least as heavy metal as the besiegers. In this instance, however, we were painfully deficient as compared with the enemy, from the fact that the Boers had long been preparing, and we had done nothing except despatch some troops hastily with the ordinary accompaniment of field guns. It was therefore a great matter that our naval officers looking beyond their immediate and ordinary duties, had devised a way of bringing up two comparatively heavy quick-fire guns and some 12-pounders, and further that the idea had been put into action so rapidly that the guns were got into Ladysmith before it was invested. Special credit is due to Captain Scott for his ready adaptation of the quick-firing mounting to such a base as enabled the 4·7in. quick-firing guns to be utilised in defence of earthworks, and done, we are told, by simply bolting it on to four lengths of pile, while he converted the 12-pounder 12 cwt. quick-firing gun into a sort of field gun by using a balk of timber for a trail attached to two wagon wheels. The value of the 4·7in. piece is obvious; it discharges a 45 lb. projectile with a muzzle velocity of 2188 foot-seconds, and is a rather more powerful and accurate gun than the Boers are likely to possess, their siege pieces being, we are told, 40 pounders. This gun would, therefore, be extremely valuable in dismounting and silencing the Boer guns at all ranges where accuracy is possible, though it is obvious that the besieger may elect to fire with safety at the fortress or town from a distance at which accuracy is out of the question, seeing that a fortress or town is a larger mark than a gun. This class of firing, however, can never produce decisive results for reasons, to be noticed presently.

The particular value of the 12-pounder gun is less immediately apparent, seeing that in Ladysmith we already had field batteries with 13-pounder guns and horse artillery with 12-pounders. It would no doubt be a good thing to add to their number, but the 12-pounder naval gun possesses certain distinct advantages over our field guns for siege work. The field battery and horse artillery guns are pieces of the same calibre as the naval 12-pounder, that is 3in., but the field battery gun weighs only 7 cwt. and the horse artillery gun 6 cwt., while the naval gun weighs 12 cwt., their muzzle velocities being respectively 1574ft., 1553ft., and 2210ft. per second. Thus the naval piece, while too heavy for the work for which the field artillery exists, has the advantage of greater energy and range and of a flatter trajectory, added to which, it is supplied with common shell instead of shrapnel only. In short, it is more of a siege gun than the others. The 15 lb. shell, of course, promises increased length and weight, gains on the naval 12 lb. projectile as the range increases, but certainly does not overtake it at any range where accuracy is attainable. It may be seen that we have not noticed the quick-fire power as an advantage, because it may be questioned if on the impromptu carriages a higher rate of fire could be attained than with our field guns, nor does it seem that it could be useful except possibly at a critical moment, such as might occur in an attempt to carry the place by assault.

It is a grand thing for an army to have behind it a fleet with officers ready to see when they can render assistance, and prompt and able in rendering it. This may, happily, be always reckoned on by us, and in cases where the operations are near the coast, as in the siege of Sevastopol, the fleet may supply better and more powerful guns than could be obtained in weeks or months from home, while the sailors are admirable gunners and full of resource, and come up often with a freshness and in numbers which enable them to perform work in a manner which may well excite surprise and admiration in all beholders. Healthy competition is a good thing, but we must be careful to judge fairly if a comparison with our field artillery is provoked, and we must bear in mind that directly the troops take the field the lighter guns will fall into their natural sphere of work, and if the heavier naval guns follow them it will be in the character of an improvised siege train. Very clever the sailors will show themselves in adapting themselves to circumstances, we are sure, and should an artillery siege train come into the field with everything specially made with a view to their needs, it would be grossly unfair to make invidious comparisons between their material and such as had been improvised by the navy.

Having said this, we may add that the naval guns' effect in Ladysmith is, we think, chiefly in keeping down the Boer fire and lessening the loss of life and the injury we receive. We do not think that any such decisive results as are attributed to them by some writers can be maintained. We read, for example, that "People say here that these guns saved the situation at Ladysmith." Without these guns the Boers would certainly fire with more impunity from a long range, but if they advanced to within 4000 or 3000 yards our field guns would prove their powers and exhibit all the accuracy that they have already displayed; so that the question becomes primarily, could Ladysmith be overcome by fire conducted at long ranges, say beyond 4000 yards? We think that no one who has taken part in a siege would hesitate to say that such a result is quite out of the question. On hard flat ground artillery fire is terrible, the projectiles and mitraille, whether it be shrapnel, ring shell, or case shot, bound and skim along the surface, literally sweeping it. As we said in a previous article, on broken or boggy ground the effect is poor, and shells falling at an angle, and bursting half on and half buried in the ground, do little more than frighten men at first, and the fright decreases, till we get such a case as occurred in the siege of Sevastopol, when one officer in fun hit another with his fist when a shell burst close to them to see if he could make him think that a piece of shell struck him. The reason of the almost harmless action of shells thus bursting is soon seen. All the fragments either go directly upwards or else strike the earth and rebound upwards. A shell bursting just before it reaches the ground is a much uglier thing, and mortar shells were thus burst over the Russians when they crowded in the Redan on the day of the capture of Sevastopol, but at very long ranges it is difficult to time fuses so to act, and under any circumstances the question is one of a very limited difference in loss of life, not one of any more decisive results.

In short, we altogether repudiate the idea that our army had got itself into a trap, for this is what the suggestion amounts to, from which they were rescued by the timely appearance of the naval contingent. This, however, need in no way detract from the cordiality with which we recognise that our naval officers had admirably foreseen the possibility of rendering most efficient help in meeting our deficiency in heavy artillery, and we have unqualified satisfaction in the knowledge that our navy has always proved itself something more than equal to whatever occasion arises.

AUXILIARY MACHINERY IN SHIPS OF WAR.

We hear but too often of failures and breakdowns in the ships of the navies of this and, indeed, of other countries, but it is not an uninteresting fact that the cause of these failures is seldom or never made public. Possibly it may be held that this is a matter of no concern for the general reader, or it may be that a belief is entertained that it would be detrimental to the service to state all the facts. But it is incontestable that if failures are more instructive than successes, which few will dispute, such a result can only be secured by acquainting ourselves with the causes of the failures. The Admiralty are largely in the hands of contractors, and it seems to us desirable that these gentlemen should be kept very fully informed as to what goes on in the engine and boiler-rooms of the ships of the nation. We understand, however, that once a set of machinery has been accepted by the Admiralty, the contractors hear very little more about it. This may not be invariably true, but we have reason for saying that the exceptions are few. In this way, engineers are deprived of just that type of information which would tend to prevent mistakes in design, proportion, or construction, and the general possession of which by firms on the Admiralty list as contractors would be of the utmost value. It will be seen in a moment that what we have said is intended to have a very wide application, by no means confined to the main propelling machinery and boilers of ships of war.

The modern marine engine is unlike its predecessors, in that it is unable to go alone. Clear all the auxiliary machinery out of the engine-room of a ship of war, and she would be helpless. In the old days a marine engine, however large, was self-sufficing. The only auxiliaries were a few donkey pumps. All the main pumps were worked by the engines themselves—air pumps, bilge pumps, feed pumps, all were treated alike, and this held good even after the introduction of the surface condenser. In the modern engine-room we have first the centrifugal circulating pump with its engines, often compound. The boilers are fed by donkey pumps of more or less special type, very often automatic, or intended to be automatic in their action. As the water-tube boiler is wholly intolerant of sea water, special distillers have to be provided to make up the feed. As grease is fatal to the boilers, special filters have to be used to get out the oil from the feed-water. We shall say nothing concerning electric lighting or refrigerating or hydraulic machinery, because we are just now considering only what is essential to the proper working of the main engines and boilers. Now, no matter how great the pitch of excellence reached by the main engines and steam generators, the failure of any one of the auxiliaries we have named will end in the stoppage of the whole machine sooner or later, according to what breaks down. Thus, for example, if the centrifugals give out, no more circulating water can be had. In order to keep the screws going resort must be had to jet condensing. Then the boilers begin to prime, if no worse effect follows, and so the utmost that can be accomplished is the reaching of the nearest port where repairs can be made. Again, if a distiller performs its duties badly, sea water has to be taken into the boilers, and again disaster is courted. The failure of a filter will ultimately have much the same result. Thus, it will be seen that risk of breakdown, instead of being concentrated in the main engines, is pretty well spread over the whole engine and boiler-rooms.

It may be urged that this very division spares the main engines. Thus, it was just as likely that the old-fashioned pump levers, for example, should break as that a centrifugal engine should fail. But this argument will not hold water. In the first place, the levers were and are made so strong, and this with much ease, that a smash is rarely heard of; but the engines working centrifugals are of small dimensions, necessarily of the high-speed type, and somewhat delicate in their construction. But besides this the need for distillers and filters and automatic pumps introduces three entirely new risks, and if we choose to tack on besides feed-water heaters and superheaters, it follows that we shall have no fewer than five new risks. We are very far from saying that these should not be incurred; they are worth it. But precautions should be taken to see that the risks of failure are reduced to the lowest possible dimensions. It is to this point that we desire to direct attention. On board warships the space available for machinery is very limited, and consequently there is the greatest temptation to keep things as small as possible. The enthusiastic inventor is always willing to promise much. It is not for him to depreciate the performance of the child of his brain. Between the desire of the contractors to save weight and space, the wish of the Admiralty to keep both down, and the sanguine views of the inventor, the auxiliary machinery of our ships of war suffers hard things, and the consequences may be, and often are, very serious. Thus in more than one ship it has been found that the distillers have been quite unable to supply the very large quantities of fresh water needed. Sea-feed has been used, and the boilers have suffered. Again—and this not only in her Majesty's Navy—filters have been used which were much too small for their work, and became choked and useless after a few hours.

At this point we are brought back to the proposition contained in the first paragraph of the article. We have said that sufficient publicity is not given to the causes of failure. Take a case in point. Some time ago there was a bad breakdown of boilers—our readers must not read Terrible or any other ship into our lines. The failure was due to sea water being put into the boilers. But the sea water was put in only because a distiller failed. Now it is surely evident that the reason why the distiller failed is a fact of very great importance. It ought to be known; but it is not known. It may have failed because it was too small, or because it was not properly managed, or because it is wrong in design or workmanship. In the eyes of the public the boilers, which are really not in fault, have to bear all the blame. It may be that a great deal too much was expected from the apparatus, or, on the other hand, that it did all it promised to do, and more, but that the demands on it were quite underrated. Here, again, let us suppose that this last hypothesis is correct, and ask, What became of the distilled water? Were there many leaky glands? Were the boilers, or some of their fittings, leaking? Did capstan engines, &c., run away with more steam than was contemplated? We very much doubt that even at the Admiralty all the information is available that ought to be. It is well understood in the service that a good captain will never call in outside help so long as he can effect repairs of any kind with his own crew. Beyond question, dozens of repairs are so made about which no one outside the ship ever hears much, if at all; and this is just as it should be. To keep on continually worrying the Admiralty about every small casualty would be very bad policy. No matter what service regulations may be, there is always human nature to deal with—human nature that even goes so far as to appropriate paint intended for one ship to beautify another. Much hard work is done in the engine-rooms of our warships of which even the Admiralty never hears. There is, however, a point beyond which this very pardonable reticence ought not to extend, and we hold, as we have said, that the Admiralty, and through the Admiralty contractors, ought to be kept fully apprised of the way in which their machinery is performing. The great engine-building firms obtain fittings and auxiliary machinery of all kinds from a score of specialists, and it is unfair to all parties to keep them in ignorance, not only of the breakdown of their work, but of the precise reason for the breakdown. If, for example, a distiller or a filter fails, instead of prohibiting the use of that particular distiller or filter in future, the maker should be told precisely how and why and where it failed, so that he may go and remedy these specified defects.

We believe that our readers, particularly those most interested in the construction of auxiliary machinery, will agree with us that excellence is not less essential in it than in the main engines. But this excellence is unattainable while experience is lacking. If the experience is confined to the engineers and artificers of her Majesty's ships, excellence cannot be hoped for. It is the man who makes the apparatus who wants experience of and in its use, much more than the man who does not make it, and can only abuse it when it fails. We may say, in conclusion, that the theory, that ample information as to the working of auxiliary mechanism of all kinds can be obtained on land, is dreadfully erroneous. It is only those who have to keep watch in the engine-rooms of a man-of-war who can appreciate the position, or understand the reason why what may do very well on land will not do at all at sea.

EARLY EXPERIMENTS IN TRIPLE-SCREW PROPULSION.

A page in the history of the practice of fitting triple-screw propellers to warships which has hitherto had little or no attention is about to be fittingly made public in the issue, by the Russian chief naval constructor, of reports made to the Russian Government by the late Dr. A. C. Kirk on the results of trials made with a small scale model and afterwards with the actual vessel—the Czar's yacht Livadia. These reports

show, it is believed, that Dr. Kirk, in his deductions on the trials, arrived at conclusions which are now established as correct in actual practice. At the latter end of 1879 and beginning of 1880, in the early stages of the Livadia's construction at Fairfield a working model, one-tenth full size, was built and taken to Loch Lomond. Instructed by the late Sir William Pearce and the late Mr. A. D. Bryce-Douglas—the heads severally of the shipbuilding and the engineering branches at Fairfield—an exhaustive series of trials was carried through under the charge of Mr. Nisbet Sinclair, then of the designing staff at Fairfield. The trials embraced experiments with screws of different kinds, with three screws, with two screws, and with one screw; and with these screws in different fore and-aft positions. Mr. Sinclair made a very full report of these experiments to the Fairfield Company. In 1887, previous to dismantling the Livadia of her machinery, a series of steam trials was made on the Black Sea by the Russian officers with the three screws, two screws, and one screw. The report of the three trials was afterwards submitted by Captain Artzeoloof to Dr. Kirk, who compared them with the original trials—Mr. Nisbet Sinclair being then the chief of Dr. Kirk's designing staff—and prepared the reports which are now to be made public. Doubtless their publication will be a generous and graceful act on the part of the Russian officials, and it is to be hoped that in addition to Dr. Kirk's analysis and conclusions, the publication will include the full details and data as to the model trials and the corresponding full-sized steam trials. Dr. Kirk, it is believed, found that the propulsive efficiency in speeds up to 15 knots was the same whether the total power was divided between two or three screws, but that for higher speeds the distribution of the power over three screws would probably be advantageous. He, at any rate, advised the Russian Government that the dividing of the power between three screws was perfectly safe, that the steering was improved by employing the third screw, and that at very low cruising speeds the third engine was a desirable feature. On the strength of Dr. Kirk's conclusions and recommendations the Russian naval officials moved forward to the employment of triple screws in ship propulsion.

THE INDUSTRIAL DEVELOPMENT OF POLAND.

During the last twenty-five years Poland has made enormous strides towards becoming the chief manufacturing centre of the Russian Empire. In the basin of the Vistula success after success has been won in keen competition with the interior governments of Russia, and Polish fancy goods and hardware are now to be met with in every part of the Empire. Polish manufacturers recognised at an early day that the chief condition requisite for the growth of their industries, in competition with Russian industrial centres, was the provision of an adequate system of trading communications throughout the whole of the Empire. That the most has been made of every available means of communication is now to be seen in the fact that every day hundreds of wagon-loads of goods are despatched from Warsaw, Lodz, and Sosnovice to all parts of Russia and even to Siberia. Commercial experts declare that at this moment the Siberian markets and those of European Russia are filled to excess with Polish goods. Even if Russia has at last begun to advance in developing its industries and manufactured products, it can scarcely expect to surpass the results of Polish activity. The industrial system of Poland is being rapidly extended, and is acquiring a sounder basis every year. In one respect the Polish manufacturers have a great advantage over their Russian competitors, since credit can be obtained by them on easier and better terms than is always the case in Russia. In addition to the "Polish Bank" at Warsaw, there are institutions in the business centres which obtain credit from abroad on favourable terms for the establishment of industrial concerns. An important factor in the striking development of Polish industry has undoubtedly been the strong feeling of patriotism which has animated the commercial classes. The continual lack of cohesion which finally led to the downfall of the kingdom is now being atoned for by the uniform solidarity observable among the Poles in commercial affairs. Wherever Polish merchants and traders are now found, whether in St. Petersburg, Archangel, Odessa, or even in Tashkend or Irkutsk, it is a noticeable fact, that they make a point of obtaining their wares from the industrial centres of Poland, so far as is possible. As compared with Russian manufacturers, the Poles recognised long ago the true value of commercial and technical education, and at once set to work to furnish fitting education on these lines. Only last year an immense polytechnic was opened at Warsaw, and the number of such institutions will be increased from time to time as the need for them arises. The Poles are a quick-witted, intelligent, and impressionable race, and it is no cause for wonder that Polish industry bids fair to play a very important part in the trade of the world.

ENGINEERS AND OIL.

We are glad to see that there appears to be every reason for anticipating not only a continuance, but a considerable further development of the present good demand for machinery and apparatus of all kinds connected with the obtaining, refining, distribution, and utilisation of petroleum. It has of late years been customary to consider that the great oil wells of the United States are being gradually exhausted, and that the world's total oil production would in consequence decline. Comparative annual statistics as to the world's supply, recently available, show, however, that America and Russia between them are still producing, in round numbers, 120,000,000 barrels of petroleum per year, and that the production of outside countries has of late so much increased that they are able to contribute between them as much as 25 per cent. Of this total, that is to say, they furnish some thirty million barrels annually, thus bringing the world's aggregate annual production at the present time to about one hundred and fifty million barrels. British engineers should find a good field in Sumatra, where the production is approximately stated at 25,000,000 barrels, and as the oil is sold at a very low price, it finds much favour in China, and a growing sphere for such machinery is also to be found in Austria-Hungary, which includes the Galician and Roumanian fields, and where the output amounts to 3,300,000 barrels, nearly four-fifths being from the Galician fields. We have every reason to anticipate an increase in the demand for oil-well boring machinery from Canada, whose production last year was 758,000 barrels from 10,000 wells, for its territory has only been partially exploited, and the capability of Canada to assist in supplying the world is considerable. In Newfoundland oil has been found in paying quantities, and the region along the coast is now being developed. British engineers may also look with confidence to Cuba and Peru. Cuba, although scarcely known as a source of petroleum, produced 90,000 barrels in 1898; and the search for oil has been intermittent, and on a small scale, while it is known that a considerable area has petroleum underlying. Peru is probably, as far as is yet known, the most promising new territory in the western half of the globe, but development there has thus far been retarded by lack of capital. Altogether, the relations between the world's oil output and the British engineering trades continue decidedly promising.

THE INSTITUTION OF CIVIL ENGINEERS.

If things were to continue as they have been at the last two meetings of the Institution of Civil Engineers, the Council would soon have to consider the advisability of erecting roomier premises. The lecture theatre, on Tuesday evening, when the discussion on the two Waterloo and City Railway papers was commenced, was again full to overflowing. Almost from the very first there was no sitting room, and numbers were forced to stand throughout the meeting. One eminent electrician was heard to remark that "at last the Civil Engineers seemed to wish to learn something civilised"—but then he was an electrician. Plainly, the fiat has gone forth that evening dress is not to be worn at the Council table. On Tuesday only one member had ventured to disobey the command. As to the discussion, one can say, without violating the laws of the Institution, that it turned much more upon the question of the electrical equipment than upon the construction of the tunnels. Professor Forbes took part in it. He was brimful of American practice, as he always is, and he advocated the Sprague system of putting a motor on every axle of a train. Several members complained bitterly that the Board of Trade should have the autocratic power of saying, without explanation, "Here is a five-chain curve; you must not travel over that at more than fifteen miles per hour." We had an interesting tale told by Mr. Galbraith, who rebelled against the action of the parochial authorities in their opposition to underground railways. Taking the discussion as a whole, it was above the average in useful character. Speakers, however, were allowed to occupy the time of the meeting too long. On Tuesday there was one member who spoke for half an hour; another for nearly twenty minutes. Both of these exceeded the customary ten minutes to an unusual extent, and, in our opinion, it is a mistake. If a member cannot say what he has to say on such occasions in ten minutes, there is a large probability that what he has to say is not worth listening to, much less recording. The consequence was that the discussion was hardly more than just begun, and will be continued next week.

DEARTH OF RIVETERS.

The Government chartering of so many of our best mercantile steamers to take troops and munitions of war to South Africa is having its effect, not only in creating a demand for the tonnage that is available, but in making shipowners spur on the completion of vessels on the stocks. In this way shipbuilders are found in the several districts advertising and beating-up for additional "hands"—particularly riveters. A Leith firm, for example, by no means amongst the largest of the shipbuilding concerns of Scotland, are advertising for—and offering every encouragement in the way of constant employment—as many as twelve squads of "steady ship riveters." From the monthly report of the Boilermakers' and Iron and Steel Shipbuilders' Society, indeed, it is gathered that no fewer than 150 full squads of riveters are urgently wanted for shipyards in the various districts. This great demand emphasises what has long been felt by shipbuilding employers, that the agreement as to limitation of apprentices, which has obtained for a considerable period, has operated most effectually in depleting the ranks of the riveters, and rendering such labour very scarce indeed. The agreement, however, has now run its course, and the employers are not likely to renew it. It is believed, on the contrary, that they will take the opportunity thus afforded them to raise the whole question of the "control of the workshop," as was done in the case of the engineers. With the unsteadiness and flagrant loss of time on the part of too many of their workmen, the employers are quite in the mood at the moment to see such a policy through to the end.

LITERATURE.

With Sampson through the War. By W. A. Goode. Thacker and Co., Creed-lane, E.C. 1899.

This is a well-got-up work, illustrated by interesting photographs; written by the correspondent for the associated Press, who succeeded in getting on board the flagship New York, and in recording all that was there to be seen for many weeks. The work, however, deals with more than the correspondent's experiences. Chapters are contributed also by Commander Todd, Captain Evans, and Admiral Sampson. The investigation into the blowing up of the Maine is discussed. In England, the fact that the Spanish Government would, indeed, be insane to encourage an outrage that was the most damaging to themselves that could well be committed, rather obscured the immediate question which was presented to the United States Government, namely, Was the explosion internal or external? If the former, Spain was unconcerned in it; if the latter, however irresponsible the agent, the owners of the harbour should be responsible.

It is impossible to follow the book through, but certain features may be noted. The tone is rather to be regretted in its advocacy of Sampson, and its persistent attack of Schley. It is natural that a correspondent on board the New York should get to "believe in" Sampson. We believe in Sampson ourselves as a vigorous, determined admiral with sound judgment, and a man in every sense—and a high-principled, generous man. From our own knowledge of him we think so, and this book gives strong evidence to this effect; but such a man does not need glorification for small things. This, we think, does harm, just as Lord Raglan rather suffered by the same treatment at the hand of Kinglake. For example, on page 159, when part of a chart-house is injured by the firing of the turret gun, Sampson's tone of voice in asking—"Was that a shell?" is commented on. The writer's own impression is that if Cervera's ships had escaped, "Sampson would have committed suicide." This last is a mere impression, and a damaging one, though evidently not so intended. So all through the war. Sampson is everything. On page 119, "Thus, Sampson originated the plan which, when afterwards carried out, thrilled the world." And on pages 142 and 143, "On June 1st Admiral Sampson arrived . . . The Admiral's plan of blockade was substituted for that of Commodore Schley, and the beginning of the end was in sight."

We think far too highly of the American navy and ships of war to be thrilled by their main fleet destroying four Spanish ships, and the chapter by Admiral Sampson, "Reasons for the Victory" would be better headed "Reasons for the Ease and Completeness of Victory." We are inclined to agree with Mr. Goode as to Sampson's action and plan as contrasted with that of General Shafter and Commodore Schley, but the latter should have their view put forward in some way. Schley is shockingly treated until the summary of his action on page 218, which almost reads as if it were written by a different author. Even this, though written, we think, with the intention to be fair, does not do full justice to Schley. Without denying that he made mistakes again and again, the fact remains that, by the Board's report, he scored far more hits on the Spanish ships than any other United States vessel, as is proved by the record of the 5in. shot hits, for he alone possessed 5in. guns. His vessel, the Brooklyn, was most exposed to attack. According to Spanish officers' accounts, she was their objective, and she lay right in their path. She was intended to be rammed. She was the first United States ship in the chase, and she alone suffered any serious casualties from fire. We have never met Schley, and believe that it is unpopular to speak in his favour, but nevertheless it appears to us only justice. As a graphic account of what took place, we commend this work to our readers.

Geologie der Erdöl-Ablagerungen in den Galizischen Karpathen. By Dr. Rudolf Zuber. First Number of First Part: The Stratigraphy of the Carpathian Formations. Royal 8vo., 88 pp. Lemberg: Published by the Author, 1899. Price 2 florins.

A good deal of uncertainty hangs over the subject of petroleum, especially as regards its occurrence and origin, and many have been the papers published concerning this interesting and valuable natural product; but the opinions expressed by different authors frequently differ very much one from the other, and only produce bewilderment in those who seek for unbiassed information on the subject. This state of things is unsatisfactory generally, and particularly when commercial enterprises dealing with petroleum are undertaken, for then the uncertainty leaves a loophole for those of speculative propensities to make use of.

Dr. Zuber has studied and investigated the subject for twenty years, and is a well-known authority in connection with the geology of petroleum and ozokerite. His knowledge has led him to conclude that petroleum winning may be made just as profitable and trustworthy an industry as any other legitimate commercial enterprise, and in support of this contention he points out that the Galician petroleum industry alone brings in a return of 10,000,000fl. annually. For the benefit, therefore, of the industry itself, and also for the scientific aspect of the question, he has set himself the task of critically collating and editing the abundant very complicated and scattered scientific material dealing with the title subject, and has incorporated the results of these labours in the present work, along with his personal observations. The work is divided into two parts—I., General; II., Special. The general part comprises the literature, stratigraphy, tectonic, and theory of the occurrence of petroleum in the Carpathians; whilst Part II. will contain a description of all the known oil fields of Galicia, and reference to analogous oil fields in other parts of the world.

In an introduction the past and present position of the question is briefly traced, and set forth with a comprehensive bibliography of the more important contributions to the literature chronologically arranged. Then follow scholarly studies of the Cretaceous system in the Silesian Carpathians and in the Galician Carpathians, and of the Tertiary system in the Galician Carpathians, in course of which the exact horizons of the various petroleum and ozokerite-bearing beds are precisely set forth. The matter is very clearly written and well printed; and the book, at least so far as the first part is concerned, can be recommended to the attention of all taking an interest in petroleum, or in the geology of the Carpathians, and more particularly to those who are engaged in or are embarking in petroleum or ozokerite enterprises in Galicia.

BOOKS RECEIVED.

Judges' Report, Awards, and Results of Official Trials, Automobil. Club Show, Richmond, 1899. London: F. King and Co., Limited Price 1s.

A Treatise on Surveying. Compiled by R. E. Middleton and Osbert Chadwick. In two parts. Part I. London: E. and F. N. Spon, Limited. 1899. Price 10s. 6d.

Chimney Design and Theory: A Book for Engineers and Architects. By Wm. Wallace Christie. London: E. and F. N. Spon, Limited. 1899. Price 12s. 6d. net.

The Fireproofing of Steel Buildings. By J. K. Freitog, C.E. First edition, first thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1899. Price 2·50 dols.

The Case Law of the Workmen's Compensation Act, 1897. Intended to supplement Part III. of "Accidents to Workmen." By R. M. Minton-Senhouse. London: Effingham Wilson. 1899. Price 1s.

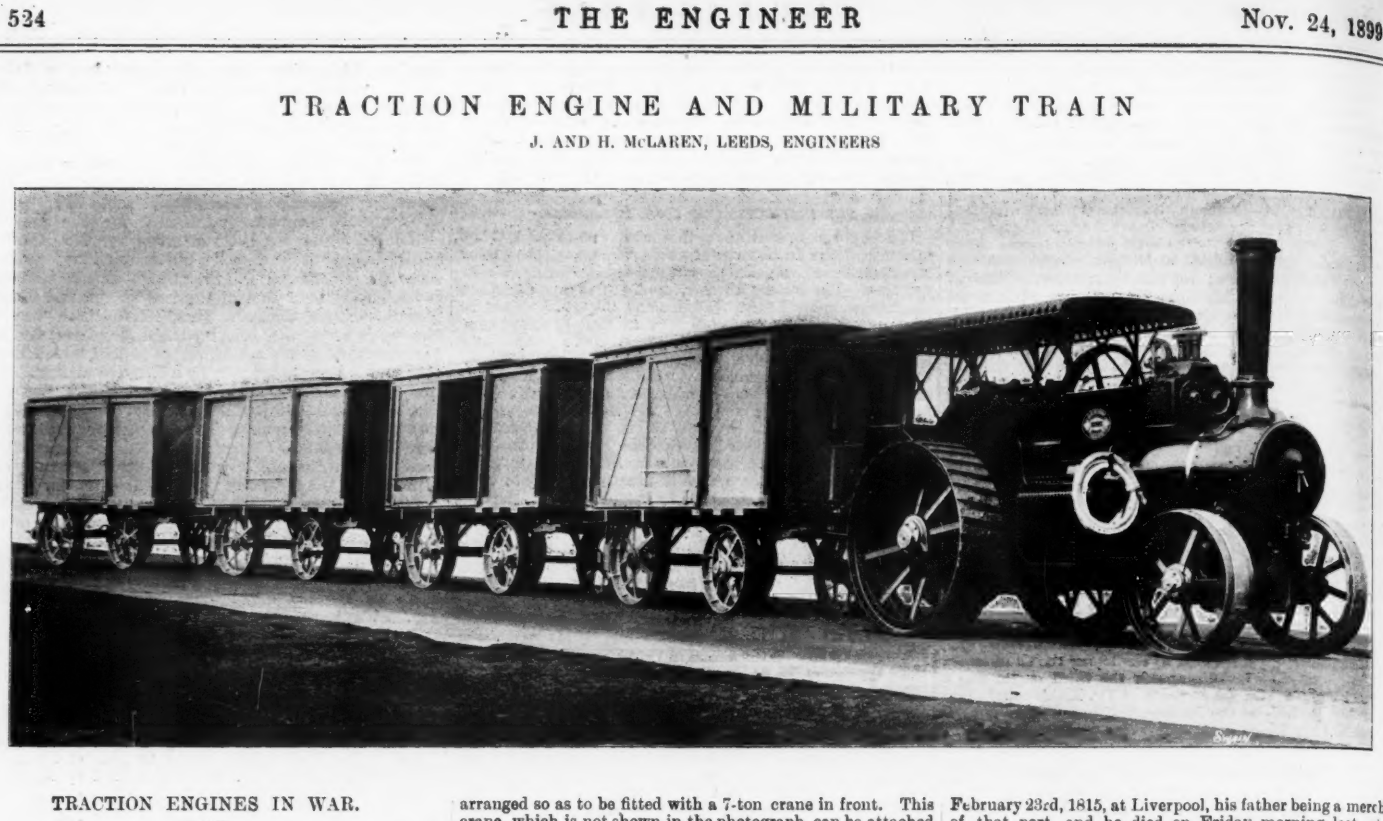
A Treatise on Masonry Construction. By Ira O. Baker, C.E. Ninth edition, revised, and partially re-written. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1899. Price 5 dols.

Exercises in Graphic Statics, with Examples of its Application to Practical Designing of Constructional Ironwork. By G. F. Charnock, Assoc. M.I.C.E. Part I., Roof Trusses, &c. Manchester: J. Halden and Co.

Portuguese Nyassaland: An Account of the Discovery, Native Population, Agricultural and Mineral Resources, and present Administration of the Territory of the Nyassa Company; with a Review of the Portuguese Rule on the East Coast of Africa. By W. Basil Worsfold. Illustrated. London: Sampson Low, Marston, and Co., Limited. 1889.

TRACTION ENGINE AND MILITARY TRAIN

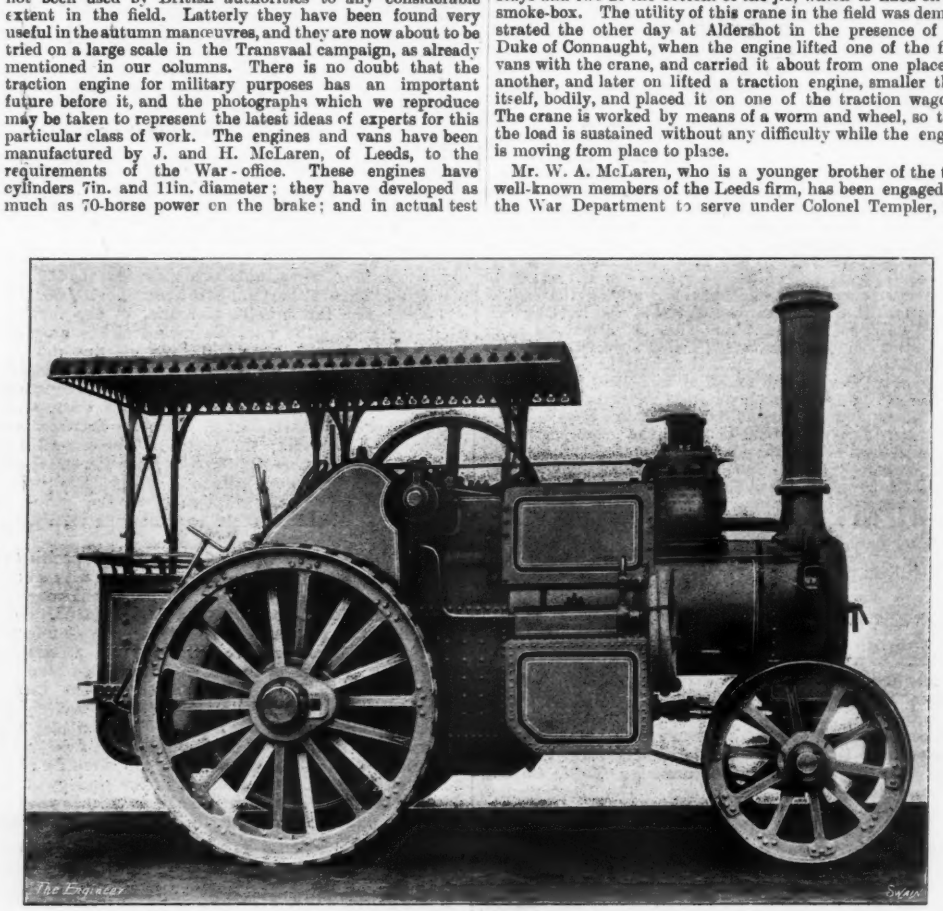
J. AND H. McLAREN, LEEDS, ENGINEERS



TRACTION ENGINES IN WAR.

TRACTION engines have been used for military purposes at Chatham for many years; but until quite recently they have not been used by British authorities to any considerable extent in the field. Latterly they have been found very useful in the autumn manœuvres, and they are now about to be tried on a large scale in the Transvaal campaign, as already mentioned in our columns. There is no doubt that the traction engine for military purposes has an important future before it, and the photographs which we reproduce may be taken to represent the latest ideas of experts for this particular class of work. The engines and vans have been manufactured by J. and H. McLaren, of Leeds, to the requirements of the War-office. These engines have cylinders 7in. and 11in. diameter; they have developed as much as 70-horse power on the brake; and in actual test hauled a load of 55 tons up an incline of 1 in 12. They are exactly similar to those which the same firm has been supplying for some years to the Johannesburg district for use in hauling material to and from the mines. The engines are on the compound principle, and are provided with an extra allowance of fire-box and grate area, so as to burn the inferior fuel which is available in that district. The water tanks are also of a very large capacity, so that the engine will haul its full load for a distance of twelve miles on bad roads without the necessity for re-filling the tanks with water. The crank shaft and all the other shafts are of extra strength and bearing surface, and the wheels are of extra width, so as to travel over soft ground without sinking. The steerage of the front wheels is effected by an arrangement of worm and rack, so as to be positive in its action, and without the backlash ineyitable with chain steerage. This renders it much more reliable in travelling along roads which are frequently mere shelves on mountain sides, and where an accident to the steering gear might involve the most serious consequences. The engine is mounted before and behind on laminated locomotive springs, as are nearly all McLaren's engines. Notwithstanding the hundreds of engines at work with springs of this kind, in no single instance has a failure of the springs been reported. The engine illustrated is arranged so as to be fitted with a 7-ton crane in front. This crane, which is not shown in the photograph, can be attached or detached in a very few minutes, as, in order to dismount it, it is only necessary to remove four bolts—two in the back stays and two at the bottom of the jib, which is fixed on the smoke-box. The utility of this crane in the field was demonstrated the other day at Aldershot in the presence of the Duke of Connaught, when the engine lifted one of the field vans with the crane, and carried it about from one place to another, and later on lifted a traction engine, smaller than itself, bodily, and placed it on one of the traction wagons. The crane is worked by means of a worm and wheel, so that the load is sustained without any difficulty while the engine is moving from place to place.

Mr. W. A. McLaren, who is a younger brother of the two well-known members of the Leeds firm, has been engaged by the War Department to serve under Colonel Templer, the military director of Traction Engine Transport in South Africa, and sailed in the transport Buluwayo last Thursday. We understand that he has had sixteen years' practical experience in pioneer work with traction engines in the Colonies, and there is no doubt his experience will be valuable to the department in its first attempt to utilise traction engines in active service. Many of the improvements in McLaren's engines for adapting them to Colonial requirements are the result of his recommendation, and the fact that he used one of these engines for wool cartage in New Zealand, which has travelled nearly 70,000 miles without a crack in the fire-box, or breaking a spring, would appear to show that they have succeeded in adapting the engine to the tasks it has to perform. The result of this latest experiment of the War-office will be watched with great interest by engineers and military men in all parts of the world.



MILITARY TRACTION ENGINE

SIR RICHARD MOON.

WE regret to have to announce the death, at the age of eighty-four, of Sir Richard Moon, late chairman of the London and North-Western Railway. He was born on February 23rd, 1815, at Liverpool, his father being a merchant of that port, and he died on Friday morning last, at his house, Copsewood Grange, Coventry. To give a complete record of Sir Richard's life would be to give the history of the London and North-Western Railway from almost its creation as a separate corporation to the present day. He was a remarkable head of a remarkable company; and though there have been associated with him many first-class men—men who have come to the forefront in the railway world—yet it is very largely due to his personality that the London and North-Western Railway occupies its present position. Perhaps the two qualities which went farthest in promoting his own and the company's success were his punctuality and his sense of discipline, but to these two must undoubtedly be added his fearlessness. He practically cared for no man. He knew his own mind, he was thoroughly self-reliant, and when once he had determined upon a course of action nothing would prevent his carrying it through right up to the end. He could not understand any one disagreeing with what he suggested—and nearly always he got his own way. Naturally those things which he did suggest must for the most part have been good in themselves. For confirmation of this one has but to consider the position of the London and North-Western Railway of to-day. A weak man, and at the same time a stubborn man, would have shipwrecked the undertaking. Sir Richard may have been the latter, he certainly was not the former. Later events may have proved, in the shape of innovations which have since appeared, that all on the Board were not quite of his opinion. If they show this, however, they show also what his power must have been, or the innovations would have appeared before. The attention he gave to details was wonderful. To him is attributable the reputation of the company for punctuality. Nothing went on of which he had not intimate knowledge. Every work in progress was frequently inspected by him, and he does not appear to have been nearly so punctual in leaving off work as in commencing it. Frequently he would work till midnight—but he would rebuke even a peer of the realm did he come late to a Board meeting, and rebuke him fearlessly. Mistakes he may have made—what man does not?—but one can judge of the effect of such mistakes, were there any, by thinking of the mighty undertaking the London and North-Western Railway now is, and what it was when Sir Richard joined the Board.

SIR RAWSON RAWSON.

ON the 20th inst. died Sir Rawson William Rawson, K.C.M.G., in his eighty-eighth year, he having been born in London on September 8th, 1812. He was educated at Eton, and commenced his public career in 1830, when he became Private Secretary to the Vice-President of the Board of Trade, and held the same office under Mr. Gladstone in 1841. Afterwards he held a number of colonial appointments, eventually being made Governor-in-Chief of the Windward Islands, which post he held from 1869 to 1875. In the year 1857 he was created C.B., being made K.C.M.G. in 1875. He was an ex-president of the Royal Statistical Society, the president of the International Statistical Society, and vice-president of the Royal Geographical Society; a member of the American Philosophical Society, the Statistical Society of Paris, the Central Statistical Society of Belgium, and the Geographical and Geological Societies of Vienna. He was the author of a large number of works, most of which dealt with colonial statistics.

DIXON KEMP.

AN eminent authority on yachts and yachting has passed away by the death, on Wednesday morning last, of Mr. Dixon Kemp. In him there was the rare combination of editor and yacht builder. He was born in 1839 at Ryde, and was therefore sixty years of age at the time of his death. For three years—1859-62—he was editor of the *Isle of Wight Observer*, and from that time forward he was yachting editor of the *Field*. He published a number of books relating to yachts and shipping, many of which are now classical, and largely helped to found, and was for many years secretary of the Yacht Racing Association. He also was largely instrumental in establishing "Lloyd's Yacht Register." He was a member of the Institution of Naval Architects, and was responsible for the design of many of our finest steam and sailing yachts.

THE CYCLE SHOWS.

For the second time the annual exhibitions of cycles, machine tools, and motor carriages, known as the Stanley and the National Shows, are being held concurrently, the former at the Agricultural Hall, Islington, and the latter at the Crystal Palace, Sydenham. The Agricultural Hall has probably never contained a better collection of machines than the present, although the numbers may have been greater. The falling off in this direction is due no doubt to the depression through which the cycle trade has for some time been passing. Most of the larger firms are still represented, but the smaller makers—or, perhaps, they should be called assemblers of parts—are noticeable largely by their absence. Nevertheless, we learn from the catalogue that there are nearly 300 exhibitors and about 1500 machines. The junior exhibition at the Crystal Palace has also suffered as regards the number of exhibits, but the more extended display of motor carriages compensates to a large extent for the reduced number of cycles. Some difficulty was experienced in obtaining the whole of the available space in the Palace for the Cycle Show, owing to a misunderstanding with the promoters of a previous exhibition, which, however, was satisfactorily surmounted eventually. The feature of this year's show is, of course, the "free wheel," which, whatever its advantages or disadvantages, has the appearance of becoming at one bound almost as universal as the pneumatic tire, and will give a much-needed fillip to the cycle manufacturing industry. In the general design of the frames there is not much to call for comment. The modified diamond frame still remains supreme, but there are to be seen a few alternatives. Of pneumatic tires the number still increases, the object of inventors being apparently to devise some means of securing the covers which shall not be held as an infringement of the Dunlop patents—an extremely difficult and delicate undertaking. In constructive materials steel still holds the field, the high expectations of aluminium and its alloys formed a few years ago have so far not been entirely realised. It is satisfactory to note that the excessive competition among cycle makers has at last resulted in the production of moderate priced machines, as an instance of which one well-known English firm is now showing a bicycle which the public can purchase for eight guineas.

Fig. 1

Turning to the construction of the frames, perhaps the most remarkable departure from prevailing custom is that of the "Little John" Cycle Company, which is particularly applicable to racing machines. Instead of the usual steering head and overhanging handle bars, this company make a triangular front, the apex of the triangle being at the front wheel centre, and the forks forming two sides of the triangle extend upwards, to form the handles for steering. It is claimed that this design gives a somewhat lighter frame, better steering, and there is less "whip" than with the ordinary indirect steering. The main frame of the machine is of true diamond shape. The Palmers Shipbuilding and Iron Company also exhibits a new form of frame, called the Harnett-Palmer, the object of which is to provide a vibration insulator. It is not a spring frame in the usual acceptance of the word, but has an additional limb over the two wheels, in which are provided springs, by compressing which the wheels can rise—when passing over an obstacle such as a brick—without communicating the motion to the frame and rider. The alteration does not improve the appearance of the bicycle, and it is questionable whether such an innovation was a necessity. Vibration is chiefly felt in the arms and hands, and to avoid this the Metallic Anti-vibration Handle-bar Syndicate have replaced the horizontal plain tube by a coiled tube of smaller diameter. Another departure in frames has been devised by the Excelsior Pneumatic Ball Tyre Company, of Hull. In this case two lever arms extend along the front and bottom forks, and take the place of the fork ends of a bicycle frame; the hubs of the wheels are attached to the ends of the levers instead of the fork ends of the bicycle, and springs provided at the other ends of the levers absorb the jolting due to unevenness of the roads.

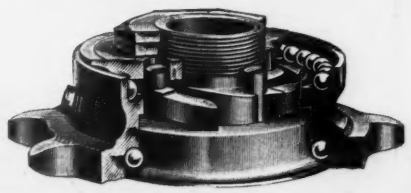


Fig. 3

In tires probably the most interesting new invention is the Radax, a double tube tire, the essential feature of which is the mode of attaching the cover. This is made to fit any of the well-known standard makes of rim, and is entirely devoid of wires, bands, and thickened edges.

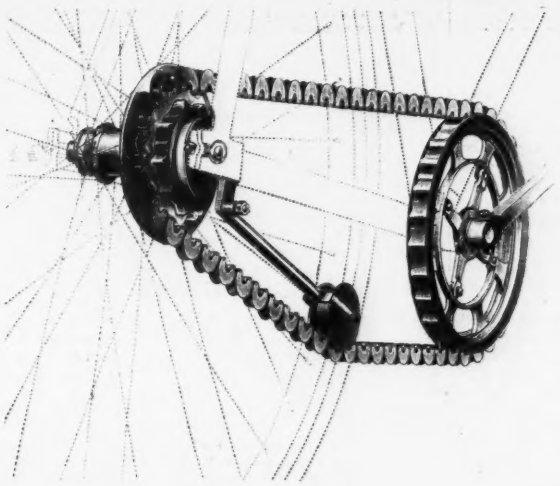


Fig. 4

Instead of these it has a larger amount of flap on the edges, and the fabric is woven in a peculiar manner, giving it a curvilinear form. This cover is remarkably easy to attach and detach. The makers are the Radax Pneumatic Tire Company, Manchester. Apart from this there is little to attract attention in connection with tires.

"Free wheel" cycles are this year to be seen on almost every stand at both shows. It is remarkable how suddenly the public taste for this machine has been developed. Tricycles having free pedals—which amount to the same thing—have been in use for some years. In these a pawl and ratchet wheel have sufficed for releasing the pedals. Then there came the Protean gear, to which is probably due the present free wheel movement. This was first shown at the Stanley Show in 1894, and it was then predicted that in the near future all bicycles would be fitted with a free wheel. Disinterested expert riders appear to look upon the free wheel somewhat sceptically, for not only does its adoption in nearly all cases add materially to the complexity of the bicycle, but the clutches generally also introduce an amount of extra friction. One may here be tempted to ask, What are the advantages claimed for the free wheel machine? They are two:—First, the saving of human energy by being able to keep the legs stationary when no effort is required, such as in coasting; and, secondly, a motionless pedal when dismounting. Against these there is to be set off the introduction of two somewhat delicate clutches and an additional brake. Although a large number of cycle makers have tried their hands at producing an original free-wheel clutch mechanism in most cases, the products evolved bear remarkable similarity to one another. Generally speaking, they are devised upon one or two well-known mechanical methods, *i.e.*, the friction clutch and the pawl and ratchet wheel. The latter being objectionable on account of the "clicking" noise produced by the passage of the pawl over the serrated wheel, friction has been largely resorted to. Amongst the devices of this pattern, probably the Morrow clutch, Fig. 1, commands the largest amount of public favour. In this clutch there are two rings—an inner and an outer. The inner ring is secured to the hub, and has cut in its periphery a number of taper grooves, in each of which is a roller, block, and spring. The outer ring carries the chain teeth. When forward pressure is applied to the pedals each roller tends to move towards the narrow end of the cavity, and the chain wheel is thereby jammed tight on the central disc, which is secured to the hub. If, however, the hub tends to move faster than the chain wheel each roller moves towards the wide end of its cavity and the frictional connection is interrupted. The blocks and springs are provided in order that the clutch shall become effective immediately a forward driving effort is exerted.

The provision of a device of this nature, it need scarcely be observed, deprives the rider of his retarding power—back pedalling—and it is therefore necessary to supply an extra brake to take its place. This is done in several ways. In some cases another clutch is provided on the crank shaft, which, with a backward pressure on the pedals, operates a cam, which in turn exerts a pull on a brake working either on the rim, tire, or hub of the back wheel. Starley and Co. have adapted the Morrow clutch to a hub brake of ingenious design, whereby with an extra back pressure on the pedals the brake is applied. This has the additional advantage that the machine can be wheeled backwards, which is feasible with scarcely any other back-pedalling device. Many of the rear-wheel clutches are based largely on the design of the Morrow, but the Otto clutch is entirely different, and appears to be based on the action of a chain pipe cutter, the expanding ring being built up of links. We hope to illustrate the construction of this device in an early issue. Garrards, of Birming-

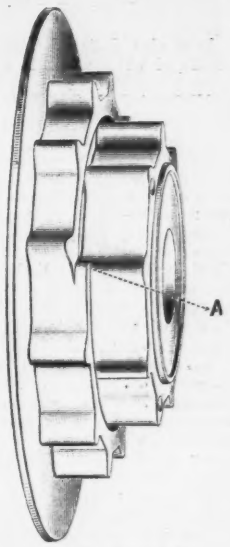


Fig. 5

Fig. 2

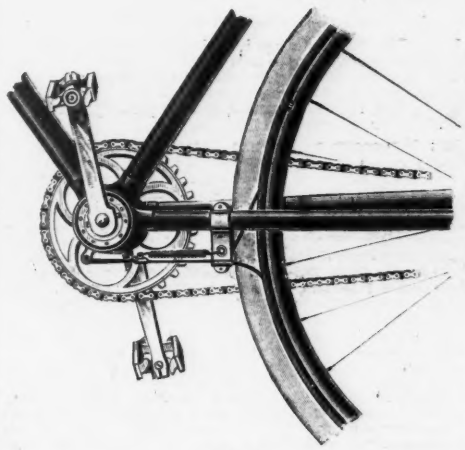


Fig. 6

Fig. 7

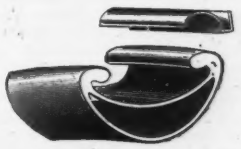
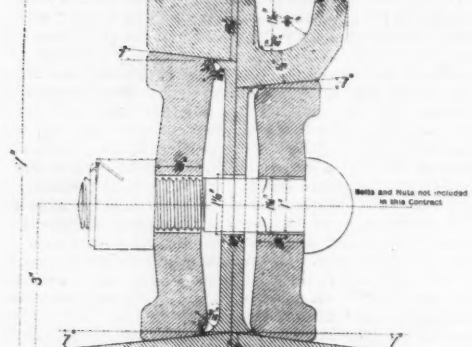
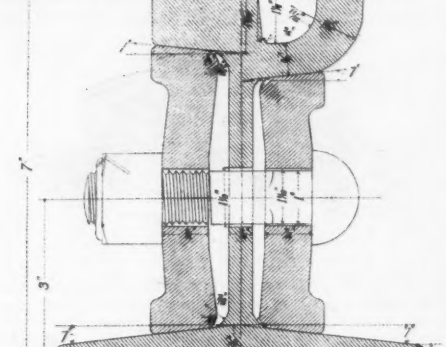


Fig. 8

CONTRACT OPEN—RAILS FOR MANCHESTER TRAMWAYS



STRAIGHT TRACK SECTION
Weighing about 100 lbs. per lineal yard.



CURVED TRACK SECTION
Weighing about 105 lbs. per lineal yard.

ham, have also designed a combined free-wheel clutch and brake, of which we shall be able to give particulars later.

The Whippet Cycle Syndicate, Limited, the originators of the Protean gear, have embodied in the Whippet bicycle a free wheel, back-pedalling brake, and a new variable speed gear, the combination of which is of considerable interest. The accompanying illustrations will enable it to be readily understood. The ratchet clutch—Figs. 2 and 3—drives from four points simultaneously, and when running freely it revolves in ball bearings, so that there is, in all conditions, a minimum of friction. The back-pedalling rim brake is actuated by a projection on the chain wheel engaging with a lever underneath the main bearing at only one point in the revolution of the pedals. The change of gear while running is effected by the following means:—On the rear hub are placed two chain wheels—Fig. 5—secured together and mounted on the free wheel. The side of the larger hub-chain wheel at the point marked A has a projection or step. A fork embraces the chain to determine its position without touching it, except when the alteration is being made. This fork is capable of sliding sideways; that is to say, it can guide the chain on to either the large or small wheel, and is operated by a lever in a convenient position to the rider. When the chain is on the smaller wheel, giving the high gear, and the rider desires the low gear, he moves the lever whilst he is riding, which guides the chain towards the large wheel. When the step A comes into the opening of the chain it engages the part of the chain that is coming on to the wheel, and lifts it up without jerk or of noise on to the larger diameter, and there it remains until the rider wishes to change again to the high gear. When the change is made from the low to the high gear the fork is moved in the opposite direction, guiding the chain towards the small chain wheel. The front chain wheel—Fig. 4—is of double width, so as to allow the chain to find its own position and maintain true alignment. The chain, it will be observed, is of special construction as regards the side links.

The interest in the brake question has been considerably revived by the free-wheel craze. A decided novelty in this connection is the rim band brake invented by Mr. Lamplugh—Figs. 6, 7, and 8. The principle of the brake consists primarily in utilising the whole of the periphery of the rim as the braking surface. To do this a band of thin metal of the shape shown in Fig. 8 is employed, being held to the ordinary rim by inflation of the tire. Around this is placed a strong vulcanised hempen cord, fixed at one end, and passing round the channel through a roller to a small lever on the handle bar. By this means is obtained a braking power that can be applied to any desired degree without damaging either the rim, tire, or machine. The small pressure on the operating lever by tightening the band round the whole rim simultaneously gives a remarkable degree of retarding force. This system can be applied equally well to either the front or back wheel and can be operated in any known manner. It is made by the Barford Manufacturing Co., Birmingham.

CONTRACT OPEN.

MANCHESTER TRAMWAYS.

THE Tramways Committee of the Manchester Corporation invite tenders for the supply and delivery of steel girder tramway rails and fish-plates, in accordance with the accompanying sketches and specification. The contract is for 5000 tons of rails—namely, about 4750 tons to Section A, and about 250 tons to Section B—and about 250 tons of fish-plates. The rails are to be of the very best quality of steel, manufactured by the Bessemer, Siemens, or basic process. Each rail shall be made from a single ingot, perfectly solid and regular in quality, and free from defects of every kind. The ingots to be subsequently thoroughly heated, and reduced by being hammered to such an extent as may be deemed necessary by the engineer or the inspector, before being rolled to the correct form. The rails must be sawn off perfectly square and neat at the ends, without re-heating, to the requisite length, and the ingots in all cases must be of ample length, to ensure a long crop being cut off. The rails are to weigh 100 lb. per lineal yard for the straight track, and 105 lb. per lineal yard for the curved track, and none which either exceed or fall short of such weights by more than 1 lb. per yard will be accepted. The standard length of rails for the straight track to be 63ft. The Committee will, however, receive lengths of 18ft., 27ft., 36ft., 45ft., and 54ft., but together not exceeding 5 per cent. of the whole quantity. The standard length of rails for the curved track to be 45ft., with a proportion of short lengths ranging from 12ft. upwards, but not exceeding 10 per cent. of the whole. Each rail is to have at each end three holes 1¼in. diameter for the fish bolts, and two holes 1⅝in. diameter for the electrical bonds, such holes to be drilled truly to template and gauge. Each rail is also to have slot holes, 3¼in. by 1 1/16in., 9ft. apart, to receive tie bars. No punching will be allowed except for the slot holes for tie bars. The fish-plates to be of the best quality mild steel, as previously described for the rails (the proportion of carbon to be from ·25 to ·35 per cent.), and to weigh 64 lb. per pair, one fish-plate in each pair to be pierced with six holes 1 1/16in. square, and the corresponding fish-plate to have six round holes 1 1/16in. diameter.

Rails will be taken indiscriminately from each lot of rails rolled as frequently as the engineer or the inspector may require, and be subjected to the following test, viz.:—A piece of rail, 5ft. long, shall be cut off and placed, head uppermost, directly on solid iron bearings, 3ft. apart in the clear, fixed on a solid cast iron block well bedded, and shall then receive successive blows from a weight of one ton, falling freely from a height of 15ft. upon the centre of the rail, which shall be capable of resisting two such blows without breaking or showing the least sign of fracture, and without deflecting more than 3in. on the length of 5ft.

The rails on analysis must comply with the following condition:—

The quantity of carbon not to be less than ·40, nor more than ·65 per cent., phosphorus not to exceed ·07 per cent., sulphur not to exceed ·07 per cent., silicon not to exceed ·07 per cent., and the quantity of manganese shall be under 1·00 per cent. Tensile test pieces, cut cold from any rail, shall have a tensile strength of from 35 to 45 tons per square inch, with an elongation of 10 per cent. in a length of 6¼in. before fracture. Any rails that may be rejected shall be at once broken up into short lengths.

Tenders are to be addressed to the chairman of the Tramways Committee, Town Hall, Manchester, endorsed "Tender for Rails," and must be received on or before Saturday, December 2nd, 1899.

LARGE BATTERIES.—Storage batteries, having an aggregate of 10,000-horse power, are to be used by the Third Avenue Railroad, of New York city, in connection with the electric equipment which has recently been put into operation upon its lines. The batteries will be placed in two sub-stations, and will probably be added to later.

THE METROPOLITAN ELECTRIC RAILWAY OF PARIS.—Extraordinary activity prevails just now in railway construction in Paris and the suburbs. There is, first, the Metropolitan Underground Railway, which is now rapidly approaching completion, and will be in full working order before the opening of the Exhibition. The work is being carried on uninterruptedly day and night to accomplish this. The length of the line from the Porte de Vincennes to the Porte Maillot is about 6½ miles, and the branch lines, Etoile to the Porte Dauphine, somewhat over one mile, and Etoile to the Trocadero, one mile—in all about 8½ miles. The line, except across the St. Martin Canal, is entirely underground, and the estimated cost is £1,480,000. The Exhibition will be reached from the Champs Elysées and the Trocadero, while access to Bois de Boulogne will be from the stations at the Porte Maillot and the Porte Dauphine. Altogether there are twenty-three stations, inclusive of the terminus stations, which are now nearly finished. The station at the Place de la Nation may be taken as a specimen of the handsome appearance of the other metropolitan stations. MM. Schneider and Co., of Creusot, have the charge of the construction of the electric power works, there being three groups of generators, each of 1500 kilowatts. One of these groups will furnish continuous current at 600 volts; the two others will supply a current at a tension of 5000 volts, which will be carried to a sub-station at the Place de l'Etoile, where transformation to a continuous current of 600 volts will take place. The rolling stock will be supplied by the Société de Construction du Nord de la France and the Société Franco-Belge, whilst the Compagnie Générale de la Traction will furnish the electric equipment, each composed of two motors of the Westinghouse type, which the directors consider to be the best adapted to the line. They have also chosen a very strong type of rail 15 metres long, with a linear weight 52 kilogrammes to the metre. The sleepers are of Pyrenean beech creosoted. Besides the Metropolitan line the following electric lines also are projected:—Circular line by the outer boulevards; line from Porte Maillot to Menilmontant; Porte de Clignancourt to Porte d'Orleans; Boulevard de Strasbourg to Pont d'Austerlitz; Cours de Vincennes to Place d'Italie. When we take into account, in addition to these, the new lines to be constructed by the Compagnie de l'Ouest in Paris and its environs, and the extension of the Orleans line to the Quai d'Orsay, there will be no lack of work next year in railway construction in the French capital and its suburbs.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

OUR WORKMEN.

SIR,—The personality of the working man is a factor which at the present day must be taken seriously into account in the management of any manufacturing concern, as the success or otherwise of an undertaking depends to a great extent on the behaviour of its workmen. I say behaviour, instead of skill, as skill is not nearly such a *sine qua non* as it used to be in engineering workmen; the scheming, planning and brainwork generally are now done by the drawing-office and management, and the workman has plain detail drawings, with every dimension on, to work to—very little is now left to his unaided judgment. Then his manipulative skill is replaced by machinery which will turn out the work much more quickly and with greater exactness.

Things were very different fifty years ago, when there was but little repetition work, and very few drawings. The workmen then were really engineers; in many cases they had to scheme out the machines themselves generally before they began to make them, as they had no drawings to work to, and even for important work the drawings were of very little use. Most engineers have seen drawings of that period; the lines on them are so fine as to be hardly distinguishable; they are beautifully coloured and shaded and the views carefully projected from each other, but there are no sections in nine cases out of ten, and only a few overall dimensions. One feels when looking at them a great respect for the men who could make a working machine from such meagre data.

The qualifications most needed in a workman now-a-days are honesty in his work, steadiness, and common sense; but these qualities are not nearly so common as they should be, and appear to me to be getting more rare every year. Workmen are too ready to shirk and scamp their work if they can do so without detection, and the great majority appear to take but little interest in it. This applies more particularly to workmen in the South of England, especially London, as northern workmen take more interest in their work and work much harder as a rule than their southern brethren. As far as my experience goes I have found that the most unsatisfactory workmen are those who have been bred and trained in London; they seem to be physically incapable of really hard work, and the majority of them are lazy and not to be depended upon. They rarely apply the laws of mechanics to their work as North-country workmen are so fond of doing; in fact, they are generally ignorant of any such laws, and will not take the trouble to learn anything after working hours. Add to this general character the fact that they are paid at the highest rate of wages, and it is not surprising that so many firms have of late years transferred their works from London to the country, or abroad.

There are several causes at the present day which are tending to lower the character of mechanics, in so far as their work is concerned, the principal one, in my opinion, being the practice of restricting each man to one particular kind of work, which is carried out in most large shops now and in new works of all sizes. By having each process in the manufacture of an article carried out by a man who does nothing but that particular work, the article can be turned out much quicker and cheaper than it would be if one man carried it through from start to finish; but while this system is productive of good and cheap work it produces very poor workmen, in fact, if it were carried a little further skilled workmen might be dispensed with altogether, labourers or boys taking their places.

It is a remarkable fact, however, that workmen themselves cannot see the matter in this light, but insist on sticking each to his own particular job, so that in time they become incapable of doing anything else, and by adhering to this principle they have almost reduced themselves to the level of automatic machines, each capable only of one or two small processes of manufacture, and the all-round mechanic, who is not afraid to tackle any kind of work, is fast dying out.

Another cause, which perhaps affects the behaviour of the men more than their skill is the very large size of modern works, rendering it almost impossible for the foremen, unless there are a great number of them, to properly supervise all their men, and bringing together large bodies of men, a number of whom are young mechanics of indifferent skill and vicious habits, and even a few of these have great influence on the quiet men who would work hard and well if left to themselves.

When works were much smaller than they are now it was easy for the foreman to observe the work and character of each man under him, and to weed out the worthless ones, but foremen now are glad to keep any man unless he is an absolute "waster," as they know that they cannot expect to fill their shops with really good men.

Another great cause of the dearth of good mechanics is trades unionism, the effects of which can be plainly seen now that it has had time thoroughly to permeate. These effects are, in the main, harmful to the best interests of men and masters alike, and are owing not so much to trades unionism itself—which I believe to be right in principle, and which might be made a great power for good in the industrial world—but to the methods and opinions of the agitators who control the unions. A noticeable result is the doctrine that all men in a trade are equal, as far as skill goes, if they have served the regular apprenticeship, and therefore all should be paid an equal wage, and incompetent workmen act on this doctrine by reporting to the union any member whom they think works too hard, that is, who works harder or better than themselves, and the union promptly informs the offending member that he must lessen his rate of working under pain of its displeasure, which, as a rule, is unpleasantly practical.

Thus, by keeping down good men and keeping out all men who have not been apprenticed to the trade, no matter how capable they may be, the unions are reducing workmen to one dead level of mediocrity, which is already beginning to have its effect on the trade of the country, and will react on the men themselves later on.

If English trade is to hold its own with that of other countries, employers must give more thought to the question of workmen than they do at present; they spend much consideration on improved processes of manufacture, arrangements of plant and works, &c., but the problem of how to get the most work from the men, while keeping them satisfied and contented, is rarely given that consideration which it deserves.

The first step towards a solution is to understand what manner of men mechanics really are, and this knowledge is only gained by working beside them for years, an experience which many managers do not possess, and to the want of which may be traced more than one trade dispute.

The ordinary better class mechanic—of whom there are still fortunately many thousands left—is a man well worth knowing, and for whom one can feel a genuine respect. He is a good-hearted fellow, as fond of a joke or a lark as any schoolboy, and rarely out of temper. He takes a pride in his work, and likes to make as good a job of it as possible. He is temperate in his habits, as a rule, although fond of his pipe and glass of beer, and strictly honest. I have known many workmen whom I would have trusted with anything. In private life he is a good husband and father, and his great ambition is to see his children rise above his own position.

Many workmen—especially the better class of young workmen—are great readers, the books they prefer being generally works on scientific subjects or social problems, for the workman cares little for novels or poetry; for him there is nothing between solid, serious books and halfpenny newspapers or comic papers. This is probably owing to his perceptions not being sensitive enough to enable him to read between the lines—incapacity in this respect being fatal to a proper appreciation of poetry or fiction.

In politics the great majority of mechanics are Liberal or Radical,

and in this matter they are rather unreasonable, their idea of government being that the workman should receive more consideration than anyone else, as they firmly believe that they are the most important members of the community, and that manual work is the only work deserving of the name.

They are very apt to lose their tempers and descend to personalities when arguing about politics, or, for the matter of that, about religion also, another pet opinion of theirs being that they help to keep all the clergymen in the country.

As far as a pretty large experience of mechanics goes, I believe that the principal characteristics of the better class men are good nature, capacity for steady, hard work, honesty and obstinacy, and these are characteristics which one would wish them to retain, with perhaps a little less obstinacy; but to do this, and to arrest the workmen in their apparently downward grade, some alteration in their treatment seems to be necessary.

An all-round improvement would perhaps be most quickly brought about by the general application of the simple formula, viz., "Pay the highest wages and get the best men."

If employers were to carry out this rule strictly, that is, if they would pay all their workmen at the highest rate paid in England for such work, or even higher, but at the same time insist that they got none but the best workmen, men who not only could work well and quickly, but who would do so as a matter of course without supervision, they would be able to turn out more and better work, while the status of the workman would be considerably raised, and the best mechanics would be contented to remain at their trade.

The practical application of this principle would cause a great outcry at first, as all workmen who failed to come up to a certain high standard of skill and character would be thrown out of work; but these men would in time find their level in other employments lower in the scale, and the benefit of their absence would soon be felt both by the employers and the better workmen.

To give the highest wages is not, however, the only thing to be done in order to secure the best men, and keep them contented; they must be treated more like men and less like machines, and their feelings studied to a certain extent.

The principal cause of complaint among workmen is that they have to start work at such an early hour in the morning all the year round; nearly every workman I have ever spoken to, young or old, complained about this, and the complaint is quite natural when we consider that, however near to the works he may live, the workman must be out of bed soon after 5.30, while in very many cases he must rise at 5.0 or before. Now, to turn out of bed at 5 o'clock on a winter's morning into the dark and bitterly cold streets without food, and to have to start work by gas-light in a workshop nearly as cold as the street, is a real hardship, not lessened by use, and it is no wonder that so little work is done before breakfast in the winter. It seems the harder to mechanics when they see many of their relations, who are clerks, &c., starting work at 9.0 a.m., and yet getting quite as much or more money. This accounts for the desire which most workmen have of making their sons into clerks.

The value of workmen depends a good deal on the kind of foreman they work under, and mechanics, as a rule, prefer a man in a higher social position for a foreman to one who has risen from being one of themselves, as such men are apt to have favourites among their men, and are often spiteful in their dealings. As long as a foreman is just and fair to his men, they do not mind how strict he is—in fact, they look down on an easy-going foreman.

To sum up, I believe that the necessary points to be observed in the treatment of workmen, in order to keep English trade in a flourishing condition, and at the same time to benefit men, masters, and the community at large, are:—First, payment at the highest rate of wages, enough for a steady workman to live decently and comfortably on with his family, and have a little to spare. In piece-work all workmen should be free to work as hard as they like, and their work should be paid for at a rate which will give them some encouragement to work hard, and the price not cut down when they are able to earn more than a certain sum. Secondly, the employment of only the best workmen; no drunken, lazy, incompetent, or dishonest men should be tolerated, and all men before being taken on should be required to pass a week's examination in the shop under the foreman's eye. Thirdly, the apprentices should be encouraged by moving them about from one kind of work to another, and by giving prizes for the best work turned out, and for the best time kept. Fourthly, during the winter months the hours should be so arranged that the men do not start work until after breakfast, the two hours before breakfast in the winter being the least profitable of any to the employers, and the least liked by the men. Fifthly, light and airy workshops which can be kept warm in the winter should be provided, and kept at a temperature of a little below 60 deg. Fah., that being the most comfortable working temperature. The men should also have clean mess rooms to take their meals in, and decent lavatories, &c., as all these things tend to increase their self-respect and good feeling towards their employers.

If these points were only acted upon by the majority of British employers the engineering trade would be placed on a sounder basis, and masters, men, and the country at large would be better off in the real sense of the term.

November 13th. R. D. SUMMERFIELD.

RAILWAYS IN RUSSIA.

SIR,—With regard to Mr. Dixon's criticisms upon my impressions of Russian railways, if I made any mistakes I am glad, because to them we are indebted for his interesting letter—doubly very interesting, as more or less being the railway authorities' point of view. But I am afraid that enthusiasm for his profession, and for his adopted country, has made him inclined to use those rose-coloured spectacles that every good railway official should keep handy. My view is, of course, the passenger's view; and the passenger is also, of course, an amateur who will not, even if he could, see eye to eye with those who do the carrying of him.

To take Mr. Dixon's letter in detail, I do not know what date time-table he quotes from, but the Nord Express, leaving Petersburg at 6 p.m., was due at Wirballen 11.15 a.m., not 10 a.m., last January. Possibly all along he has been thinking of the summer service, while I have been writing of the winter one. The ordinary express that he quotes is, I think, only summer service anyway.

Mr. Dixon kindly leaves me a loophole by suggesting the language difficulty, but I shall not seek to take advantage of it. I certainly speak but little Russian, but all the people with whom I discussed the train service spoke French, if they did not also speak English. I did not have to try and blunder at things in a mixture of Russian and German, and most of our points of difference depend, I fancy, on the point of view.

In discussing the reasons for slow speed—well, of course, I was a passenger only, but the reason given is the one that I invariably heard. I certainly cannot take ground on it further than that. I did not examine any of the lines. The lines, with the laying of which Mr. Dixon or any of his fellow-countrymen are connected, are, I have no doubt, well built, but then they are not Russians. I notice that Mr. Dixon makes no comment on my statement "that railway accidents are unknown in Russia"—a thing I was told in season and out, and, for my happiness, believed. I have—since writing, and just previous to publication of the article—been told by Russians that "accidents, and bad ones, are very common, but they are seldom or never heard of, because hushed up." There is an epidemic of attempts at train wrecking on some lines—this my article implied. Then, too, Russians have told me with any amount of detail, tales of disasters—particularly one to a heavy military train, when the rails split outwards, and there was a great loss of life. All this bears out what I said about the lines being unable to stand fast heavy trains.

As to arriving at a station an hour before starting, I can only say that I left Russia by the 6 p.m. Nord Express, and had to be at the station about 5 o'clock. Numbers of my fellow passengers were there before me. A fixed tariff for excess luggage undoubtedly exists, but that does not ensure its being adhered to. It was in my own case, but a fellow-passenger with less luggage paid a good deal more than I did. An obliging policeman had charge of mine. Then as to droskeys—they certainly were *not* admitted to the Baltisky Station-yard unless ordered. I learned that to my cost. Nor can much luggage be carried in one, though on this occasion I did not happen to have any. When I did, on the occasion of my first arrival, the delay was nearer an hour than "five or ten minutes." Possibly as my ticket was through from London, while my luggage was re-labelled at Berlin, some side issue may have tended to delay; but, on the other hand, as the *aids-de-camp* of a Grand Duke came to the station to look after me, I feel justified in fancying that an abnormal delay was unlikely. No one hurries in Russia—to my mind, a charm compared to English hurry and rush. With regard to lights, I missed the Nord at Brussels, as those who go *vid* Calais in bad winter weather usually do, and so went on by ordinary express. In each compartment in Russia there was one candle provided. Wise passengers had others of their own providing. I left Russia by the Nord express in January last, and again each compartment had but a candle, and that burned out before dawn. The Nord outside Russia had, I think, the electric light which your correspondent describes. If I remember rightly, there was electric light in the Russian dining-car.

As regards engines, Mr. Dixon has taken me too seriously. It was the very high funnels of some locomotives that made me think of Puffing Billy. It is only the difference of standpoint that puts us at variance here. As for the makers of engines—well, I reckoned from the names of English, American, or German firms that I read on the engines; to the layman that seems conclusive proof. As regards English engines, I recently read something about an order for 600 for the Trans-Siberian Railway. As regards Russian-built ones, engines designed by foreigners, or whose construction is superintended by the "stand-by man," cannot, in my view, be strictly called Russian. The solitary Russian engine to which I referred broke a connecting-rod on the trial trip—so a man who went on the trip told me.

In conclusion, I take it that Mr. Dixon is an admirer of Russia and the Russians. So am I. Both of us, I take it, like to see such of Russia as most interests us through rose-coloured spectacles. So Mr. Dixon warmly upholds Russian railways with a determination to see nothing but the best. But, surely, the fact that he is there, managing railway works, proves my contention that Russia cannot yet stand alone in engineering matters. That Russian works, with him and scores of others bearing a hand, will hold their own against foreign competition, is another affair altogether. None of the engines he mentions will come under the definition of "Russian" as I understand it, *i.e.*, constructed by Russians entirely "off their own bats."

THE WRITER OF THE ARTICLE.

AMERICAN COMPETITION.

SIR,—With reference to the letter of the British Insulated Wire Company, Limited, appearing in the issue of your journal of the 17th inst., our clients, the National Conduit and Cable Company, instruct us to state that the facts alleged therein are inaccurate, and the conclusions drawn are misleading; and we have already, upon their instructions, commenced an action for libel against the British Insulated Wire Company, Limited.

We are to ask you to be good enough to insert this letter in your next issue, together with a statement that your journal must in no sense be taken to concur in the imputations or purport of the British Insulated Wire Company's letter.

RENSHAW, KEKEWICH, AND SMITH.
2, Suffolk-lane, Cannon-street, London, E.C.,
November 20th.

[The letter to which reference is made is the only information we possess. Messrs. Renshaw, Kekewich, and Smith have no doubt overlooked the standing head to our correspondence columns.—ED. E.]

FRICTION OF COMPRESSED AIR IN PIPES.

SIR,—"Wind" is quite right in his use of the text-book formula. In order to get 10 lb. pressure at the delivery end of a 3in. pipe carrying 250 cubic feet of free air per minute through a length of 3000ft. it seems that I must have 47·4 lb. on the gauge at the inlet end. That is, the loss of pressure = 37·4 lb.

The following table shows the rather anomalous results obtained in the application of the same formula $\left(H = \frac{V^2 L}{10{,}000\ D^5 a} \cdot \right)$ to a wide range of pressures, where D = 3in., L = 3000ft., a = ·73.

Pressure at delivery end, pounds per square inch.	V = vol. delivered in cubic feet per min.	H = head of pressure required to maintain flow, pounds per square inch.	Initial pressure required, pounds per square inch.
5	186·5	58·8	63·8
10	148·7	37·4	47·4
20	105·9	19	39
30	82·2	11·4	41·4
40	67·1	7·6	47·6
50	56·8	5·4	55·4
60	49·2	4·1	64·1
70	43·4	3·2	73·2

But what is the loss in energy—the loss in work? Is not the increase in volume equivalent to the loss in pressure? Take the case in question. The initial pressure is 62·4 lb. absolute, and the initial volume $250 \times \frac{15}{62{\cdot}4} = 60{\cdot}09$ cubic feet per minute. The delivery pressure is 25 lb. absolute, and the volume delivered is $250 \times \frac{15}{25} = 150$ cubic feet. The energy received is 60·09 × 62·4 foot-pounds of air, and the energy delivered is 150 × 25 foot-pounds of air, and these are equal. From whence, then, comes the work done on the way—the rubbing of the pipe? It must be due to the loss of whatever heat there may be in the receiver; but this is very small. The problem is a very interesting one, and no book that I have seen makes it clear.

One excellent authority whom I consulted, a well-known expert, when he heard of the proposition to send 250 cubic feet free air through a 3in. pipe 3000ft. long, at 10 lb. pressure, said at once, "Increase your pressure to 75 lb., and put on a reducing valve to get down to 10 lb." But why? The distress of the compressor would be greater in that case.

Compare the cost of compressing to 62·4 lb. absolute, with the cost of compressing to 90 lb. absolute pressure.

In the first case the mean steam pressure per stroke is—

Before cooling ... ... 26·50
After cooling ... ... 21·15 } a loss of 20 per cent.

In the second case the mean steam pressure per stroke is—

Before cooling ... ... 35·23
After cooling ... ... 26·65 } a loss of 24·3 per cent.

Thus, it would appear that, while there would be a loss of efficiency in using the high-pressure as far as the compressor is concerned, there would be no gain in the cost of transmission, for the loss in transmission could not be less than nothing.

November 20th. J. M. F.

SIR,—Your correspondent "G. L. W." suggests that a solution of the "apparent contradiction" alluded to in my letter of the 2nd inst. will be found in the increased velocity of the air when compressed to 10 lb. only. This solution leaves me pretty much where I was before—for the anomaly still remains that we must have the same initial pressure, and therefore the same expenditure in horse-power to convey 250 cubic feet of free air compressed to 10 lb., as we should have to convey it if compressed to 40 lb. square inch.

We may carry the argument a step further, and assume that the 250 cubic feet of free air is to be carried when compressed to 30 lb. through a 3in. pipe 3000ft. By the same formula we get

$$H = \frac{82{\cdot}2^2 \times 3000}{10{,}000 \times 243 \times {\cdot}73} = 11{\cdot}4,$$

or 30 + 11·4 = 41·4 lb. square inch in initial p.

This, I think, pretty conclusively proves that there is a "screw loose" somewhere, as we are apparently able to convey the air at 30 lb., with a less initial pressure, and consequently with less cost in horse-power, than for air at 10 lb.

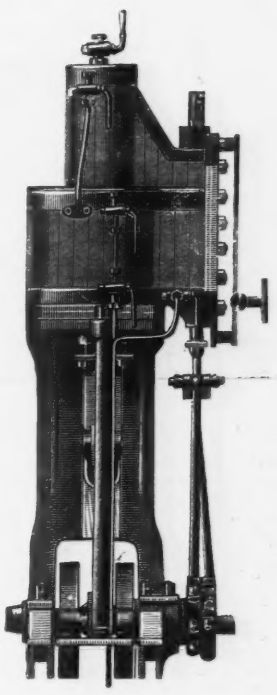
In view of the increasing use of compressed air, it certainly seems desirable that a little light should be thrown on this subject. This would be welcomed doubtless by others as well as by WIND.

East Finchley, November 20th.

SINGLE-CRANK COMPOUND SCREW ENGINES.

SIR,—We note in your issue of November 10th a description and illustration of a compound engine by the Vauxhall Ironworks. This engine we see you consider "worth passing notice;" in your next issue of November 17th we find Mr. F. T. Harker claiming priority for the arrangement.

As engineers we like to be accurate, and beg to enclose illustration of our Kingdon engine as patented by us in 1879; patent No. 745, February. We were the first to introduce this type of engine, which in early days had a considerable success. We have



KINGDON COMPOUND ENGINE

now, however, practically discontinued making these single engines except for special purposes, as for most of our work engines of a modern type have superseded the older pattern.

Among other imitations we have had in our possession for some years a German version, an almost exact duplicate of our design.

We think the above will satisfy your readers as to the origin of the above-mentioned design, which we had flattered ourselves was pretty well known, as a speciality of ours. If the engines you have already illustrated are imitations, we can but feel flattered; if they are not, they can be best accounted for by the well-known cyclic recrudescence of inventive genius.

For SIMPSON, STRICKLAND AND CO., LIMITED,
PHILIP P. ALEXANDER, Managing Director.

Dartmouth, S. Devon, November 20th.

SIR,—In reference to your correspondent's letter *re* our tandem engine, which you were good enough to illustrate in your issue of the 10th inst., it will be patent to most engineers that there is nothing particularly novel in the type. We are therefore not a little surprised that Mr. Harker should claim his as a novelty. We submitted the illustration as an example of a suitable and well-designed engine for the purpose for which it is required, viz., to run for long periods in the hands of natives on the African lakes and rivers without any special attention or repairs. This accounts for extra strength and wearing surfaces, which were specially introduced, and which Mr. Harker appears to object to so strongly.

THE VAUXHALL IRONWORKS COMPANY, LIMITED.
(J. H. CHAMBERS, Managing Director.)

Wandsworth-road, London, S.W.,
November 22nd.

PETROLEUM IN STEAM BOILERS.

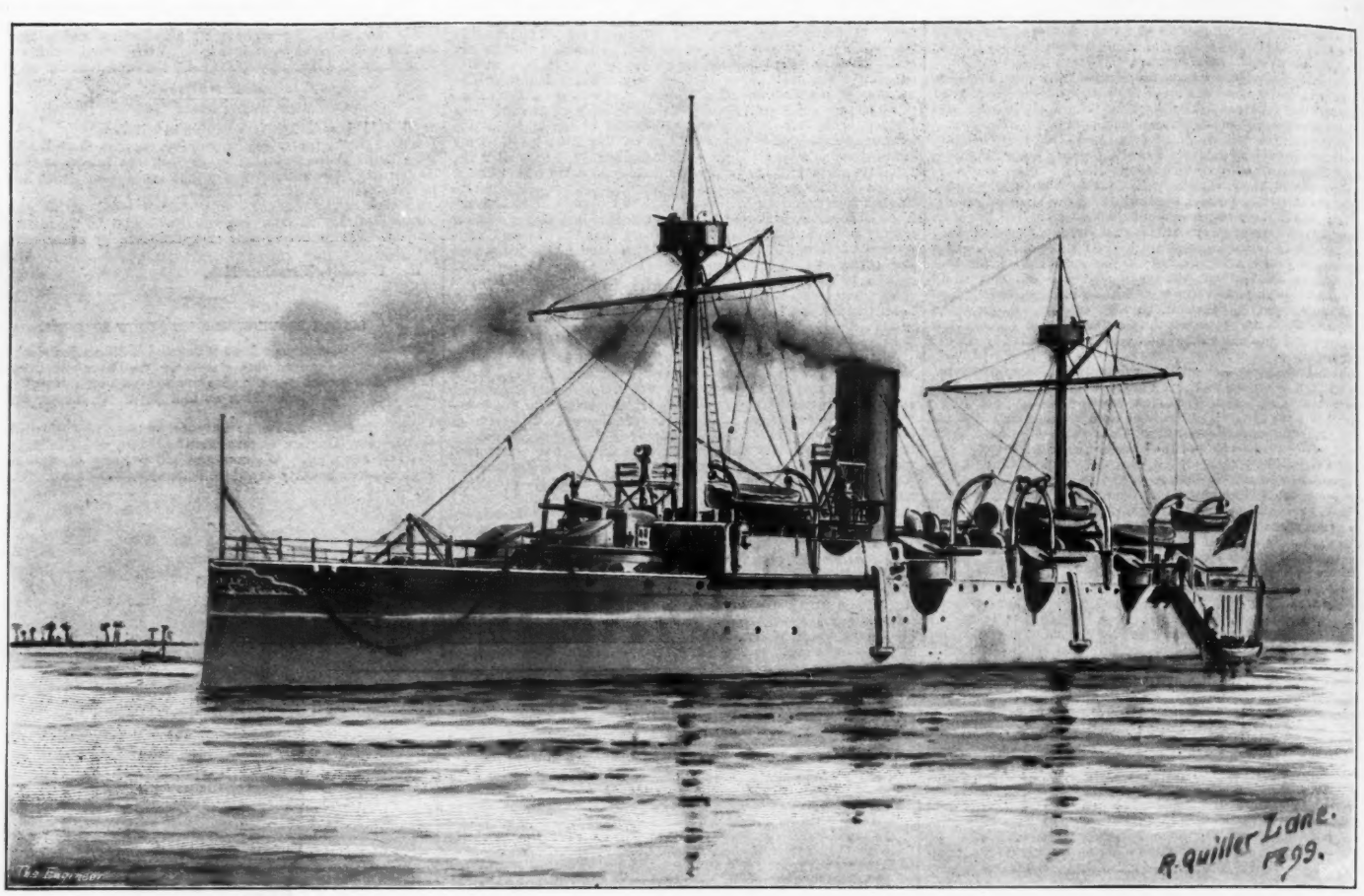
SIR,—May I take the liberty of asking the opinion of your readers who have tried the experiment as to the wisdom of using petroleum in the feeding of boilers for the prevention of scale. I am working two boilers 9ft. diameter and 32ft. long, and am using about three quarts a day of petroleum forced in through the economiser along with the feed-water. Somehow, lately, I have frequently had to have repairs done in the steam piping in different parts of my premises, steam piping ranging from ¼in. up to 2in. straight lengths, bends, &c., having become holed, in some cases the piping has only been put in three years ago.

Would your readers kindly let me know if they think this is the result of using petroleum, and, if so, I am afraid it may be having a bad effect on my boilers.

Formerly I used soda in feeding, but had to abandon that, as it had such a bad effect on all the gun-metal valves; it was impossible to keep them tight.

November 17th. A SUBSCRIBER.

THE UNITED STATES CRUISER CHARLESTON



THE UNITED STATES CRUISER CHARLESTON.

THE engraving above illustrates the United States cruiser Charleston, whose wreck has been recently announced. She was in several respects an interesting vessel. She was constructed at San Francisco, and for her size carried a heavy armament consisting of two 8in., six 6in., and four 6-pounders, besides several smaller guns. Her displacement was 3730 tons. Her twin-screw engines indicated 6600-horse power, giving her a speed of 18 knots. She had four torpedo tubes. Her length was 312ft. 7in.; beam, 46ft. 2in.; depth, 21ft. 8in. She cost £209,000. She had an armoured deck from 2in. to 3in. thick, and carried 328 tons of coal, which could be made up in case of need to 750 tons.

For the period at which she was built she was a good ship, and reflected credit on United States builders.

The Charleston was wrecked at 5.30 on the morning of the 2nd inst., on a coral reef not marked on the chart, three miles to the north-west of the Guinapak rocks, which are situated north-east of the island of Luzon, one of the Philippines. All on board were safely landed on Kamiguin Island. The natives on the island were friendly. Lieutenant McDonald made for Lingayen Gulf in a sailing launch. When he left there was no opportunity of examining the condition of the vessel with a view to salvage operations, as a north-easterly monsoon and a heavy sea prevailed. The admiral reports that the ship struck easily and then thumped violently. The fire-room was completely flooded. The first water-tight doors were closed promptly. The ship lies settled aft, but is well out of the water forward, resting apparently on a very steep bank. According to latest advice there was some hope of saving her.

LOCOMOTIVE TRAFFIC IN LONDON.

THE London County Council is now taking the initial steps with a view to putting into force the provisions of the Locomotive Act, 1898, within the administrative county of London. Under Sec. 6 of the Act the Council is empowered to make bye-laws regulating the use of locomotives within the county, exclusive of the City, where the Corporation is the authority under the Act; but any bye-laws made by the Council are subject to the confirmation of the Local Government Board. Certain bye-laws have already been prepared on behalf of the Council, but the question of restricting the use of locomotives within certain hours, and of entirely prohibiting their use in certain thoroughfares, as suggested by the metropolitan road authorities, is still under consideration. The by-laws which have been adopted by the County Council are briefly as follow:—

(1) A person in charge of a locomotive on any highway shall not use it to draw more than three unloaded wagons, with or without any wagon solely employed for carrying feed-water. This prohibition will, however, not apply in any case where, on application to the County Council for permission to use a locomotive on any specified journey to haul more than three wagons, written sanction is given for that purpose.

(2) A person in charge shall not cause or permit the locomotive to remain stationary on any part of a highway for more than twenty minutes at any one time. This bye-law shall not be deemed to apply in any case where the stopping of the locomotive for a longer period is necessary to enable the user to comply with the requirements of any statutory provision, or bye-law for the time being in force for the regulation of locomotives, or is rendered necessary by accident or other unavoidable cause, or is required in case of a steam roller lawfully on any highway for the purpose of the maintenance, repair, or construction of highways.

(3) Where for a continuous length exceeding fifty yards a highway comprises a carriageway or cartway of a width less than 24ft., the person in charge shall not cause or allow the locomotive to enter upon the thoroughfare until he has ascertained that that length is clear of vehicles, and until a person accompanying the locomotive has preceded it to a sufficient distance to warn the drivers of vehicles of the approach of the locomotive.

(4) The locomotive is not to be caused or permitted to remain stationary on any highway, so that any wheel rests on any bridge, arch, or culvert, or within 10ft. from the face of the abutment of any bridge, arch, or culvert. This provision will, however, not apply in any case where a steam roller is lawfully employed on road works, where a locomotive may be required to be instantly stopped in pursuance of statutory provision, or where the stopping may be rendered essential by accident or other unavoidable cause.

(5) The person in charge who may be required by an officer of the London County Council or a police constable to stop the locomotive for the purpose of ascertaining whether any provision of any statute or bye-law applicable to the locomotive has been complied with, shall at once stop the locomotive for such time as may reasonably be considered necessary for the purpose of such examination. The driver shall also render such reasonable assistance as may be required in connection with the examination.

(6) The locomotive shall not be caused or allowed to be driven on the same track as another locomotive preceding it at a less distance than 200 yards, except where there is reasonable necessity for so doing.

ELECTRIC LIGHTING AMENITIES.

AN anomalous position of affairs in connection with electric lighting on a portion of the boundary line separating the large parishes of St. Pancras and Islington has prevailed during the past eighteen months. It appears that some of the residents in York-road and Brecknock-road over a year ago caused their premises or dwelling-houses to be wired for electric lighting in anticipation of receiving a supply of current from the mains of the St. Pancras distributing system. It was known that some, if not all, of the buildings in these two thoroughfares were situated in the parish of St. Pancras, but it was subsequently found, owing to the idiosyncrasy incidental to the ancient system of demarcating London boundaries, that the carriageways and footpaths of those roads were vested in the parish of Islington. The residents in Brecknock-road and York-road whose premises had been wired were thus placed in an awkward position, as it was impossible for the Vestry to open the roads of an adjoining parish in order to lay distributing mains to serve property rated in its own particular district. In this dilemma the St. Pancras Vestry approached the Islington Vestry with a view to obtaining sanction to the laying of mains for the purpose in question, but the latter pointed out that it had no authority to grant the desired permission to disturb the roads. At the same time it indicated a way out of the difficulty, which, it is surprising to say, was not properly appreciated by the other authority. The proposal was that Islington should lay the mains and sell the current to St. Pancras, which in turn would charge its own customers for the units used by them. Not satisfied with this offer, the St. Pancras Vestry next asked the Board of Trade to sanction the erection of overhead conductors, but the Board declined to permit this being done. The Board intimated that the question was really one for friendly settlement between the two authorities, and that if an arrangement were arrived at, the Board would not interfere in the matter. Negotiations were again resumed with the Islington authority, which, three or four months ago, resolved not to offer any opposition to an application being made by the St. Pancras Vestry to the Board of Trade for a licence, under Section 3 of the Electric Lighting Act, 1882, to lay mains outside its parish for the purpose in question. It is scarcely necessary to say that both authorities were under the impression that a solution of the problem would be arrived at in this manner; and even the residents in Brecknock-road and York-road, tired of waiting so many months for the lighting of their domestic installations, began to hope that patience would at last be rewarded by success. Unfortunately, these anticipations have not been fulfilled, and the Board of Trade, although disposed to wink at an illegality that might be committed by the two authorities in arranging for the underground of mains on the boundary line, has straightened its back, and declined to be a party to the transaction in any way whatever. This fact will be understood when it is mentioned that the Board last week informed the St. Pancras Vestry that the power conferred upon the department, under Section 3 of the Act, is a power to grant licences authorising "the supply of electricity" within any area. The application of the Vestry, the Board continued, was for a licence merely to lay mains in two Islington roads, but not to supply within any portion of that parish. In these circumstances the Board expressed its inability to issue a licence, and at the same time repeated the suggestion made a year ago, that the matter seems to be one for friendly conference between the two Vestries. The distinction drawn by the Board of Trade between the supply of electricity and the laying of mains is exceedingly fine, but it has had the effect of inducing St. Pancras once more to approach Islington with a view to obtaining the necessary permission for laying mains and service lines. What the result of the application will be remains to be seen, but it is little satisfaction to the expectant customers to be deprived of light after going to the expense of employing wiring contractors, and to find that after negotiations extending over a year the *status quo* yet prevails. There is, however, hope for the future, apart from any arrangement which may be arrived at between the two parishes on the particular question of main laying. This hope, which also suggests the means of solving similar difficulties in other parts of the metropolis, lies in the decision of the Commissioners appointed under the London Government Act, 1899, to make the centres of the roadways the boundary lines between different parishes, and in these circumstances it would be practically impossible for any difficulty of the kind referred to to recur after the Act comes into operation next year. In the case of Islington and St. Pancras, the Brecknock-road and the York-road, according to a statement made by the Islington Vestry clerk on Friday, are proposed to be centrally divided, and if this takes place there should be a speedy termination to what has been a rather unpleasant and tedious incident in so far as St. Pancras is concerned.

THE London County Council have approved of the draft form of orders, of the Deptford, Shooter's-hill, and Woolwich Light Railways Order, and have authorised orders with regard to the proposed light railways—(*a*) Clapham and Kingston-road; (*b*) New-cross and Eltham; and (*c*) Archway-road, Highgate, and to deposit them with the Light Railway Commissioners.

MODERN DEVELOPMENTS IN PERMANENT WAY WORK.*

By E. E. Russell Tratman, C.E.

(*Concluded from page* 491.)

The use of steel ties continues to extend in Europe and other countries. Some of the new railways in Africa are laid with such ties on account of the destructive activity of the red ants, which appear to relish a nice fresh tie as the average boy relishes a nice fresh pie. Steel ties are making little if any progress in this country. They have been tried more extensively by the New York Central Railroad than by any other road, but the results have not been entirely satisfactory, though two forms of ties were used. At Garrison's, N.Y., there are 1576ft. of track laid with 721 of Hartford's ties. These have proved durable, having been in use ten years, but to keep them in surface requires nearly twice as much work as for wooden ties. They are also said to be hard to line, while the ballast shakes away from them, and they give a rattling sound from the stone ballast and the bolts. Near 110th-street, New York, this road has about 3375ft. of track laid with 1350 steel ties of a modified form, known as ox-bow ties from their shape, the depressed centre part being covered with ballast. After some years' service these are being replaced with oak ties. They were less satisfactory than the others, and their shape prevented the economical lining of the track, while they break more readily in the middle and crush under the rail.

We now come to the subject of rails, in which there has been little development except in size and quality. One novelty, however, is the Manning unsymmetrical rail, about 1300 tons of which have been ordered for experimental purposes. It is claimed that its life will be nearly twice that of an ordinary rail before being taken out of main track, but it is doubtful whether any such result will be obtained. The increased life is to be attained simply by the addition of a thickness of $\frac{5}{16}$in. on top of the head, and about $\frac{1}{16}$in. of metal on the running or gauge side of the rail head, so that one half of the head is wider than the other. The idea is that the rails will give their full life before being turned, the inventor claiming that turned rails do not give a good bearing for the wheels. As to improved fastenings of rails to the ties, I am sorry that there is nothing to show. A few small experiments have been made with screw spikes, but apart from that we still nail our rails to the ties with more or less inefficient spikes, which require constant attention. This is a discouraging condition for a structure which costs millions of dollars yearly for maintenance. There is little prospect of any better device being introduced, but bolts, wedges, or clamps must be used with steel ties on a concrete substructure.

Coming now to the question of joints, however, we have a subject which could be discussed indefinitely. It seems to me that one of the most important steps which has been taken is that of providing some form of base support for the ends of the rails, this base being supported either by the ties or by some part of the joint device. Of equal importance are the efforts to improve the quality of the metal in the splice bars, and to improve the fit between the bars and the rail. As a general thing they should be of harder steel, and more carefully fitted to give a full even bearing. Most of the recent joint devices now in use have a base support for the rail. A novelty in joint fastenings, dispensing with the use of nut locks, is a nut made of spring steel, with curved flanges. It is tapped for the bolt, which is screwed into the nut, drawing it flat upon the splice bar. This has been used successfully at crossings and curve guard rails, where ordinary bolts have lasted but a short time.

Another form of joint which has been heard of lately in this country has a rail or bar laid outside the track rail at the joint in such a way as to take the bearing of the wheel and so relieve the ends of the track rails from the load. The idea is fifty years old, and is not very promising, as it involves a transfer of the load to the joint rail and back to the track rail which will probably be hard on the track and on the cars.

In regard to points or switches, the only great novelty is the Duggan switch, having rails moving vertically instead of horizontally. It seems, however, that it has not come up to the expectations, the greatest difficulty being that the diversity of distances back to back of wheels leads to derailment. The switch is therefore not found advisable for use where trains run at high speed. In the standard switch of the Netherlands State Railways the 18ft. switch rails have pivot or hinge joints instead of bolted fish-plate joints at the heel. A lug or pin in the base of the rail works in a recess in a special heel casting. The stock and switch rails rest on steel base plates 19ft. long and 12$\frac{1}{2}$in. wide, and creeping is prevented by bolting the heel filler block to the bed-plate, behind the 6in. by 12in. timber which carries the heel hinge castings. Under the toe of the switch, the bed-plates are connected by a pair of angle irons which rigidly maintain the gauge. A single head rod is used, and is not adjustable.

The switches on the sharp right-angled curves of the Chicago elevated loop are interesting in the arrangement for supporting the switch rail. A guard rail is placed close to the rail on the side of the curve, and is extended behind the switch rail, so that when the switch is set for the curve the switch rail is firmly supported to resist the blows from the wheel flanges in taking the curve. All the points, crossings, and diamond crossings in the yards of the Boston terminal are of 100lb. rails, and are fitted with an anti-creeping device at the heel joints of all moving rails.

Cast steel crossings have been tried on a very limited scale in this country, but on the Netherlands State Railways they are used almost exclusively. They are of crucible cast steel, and are reversible. Great care is necessary in the design and in the manufacture to ensure accuracy of shape, with smooth, hard surfaces, free from flaws, blow-holes, and brittleness. The manufacturers guarantee them for five years against defects, but do not guarantee them for wear, since that depends largely upon the traffic.

I might also call your attention to the use of angle iron for guard rails at crossings, the Duluth and Iron Range Railroad using angle irons 6in. by 6in. for frogs made of 100 lb. rails.

Mechanical crossings, which give an unbroken rail for the main track or the siding, according to the position of the switch, date back forty years or more, but have not met with much favour. In most of these cases the principle is the same. The siding rail is elevated sufficiently to bring the wheels up so that their flanges will clear the top of the main rail. This main rail is continuous, and in the gap by which it passes through the siding rail is a pivoted rail of special shape, operated in connection with the switch. This rests upon the main rail when the switch is set for the siding. An automatic connection is provided, so that a main-line train trailing through a crossing set for the siding will throw the movable rail open, and so set the switch before the train reaches it. A careless man might sometimes throw the switch before a train taking the siding had cleared the crossing, and would thus open the crossing and cause a derailment. To prevent this, a detector bar is sometimes applied, as in interlocking work, to prevent the switch from being thrown until every wheel has cleared the fouling point.

It has been objected that the connections between the switch and frog are liable to derangement by creeping or expanding track, and are also liable to injury if a car comes off the siding when the switch is set for the main line. These particular objections, however, do not seem to have much force when we consider the great extent and successful operation of interlocking apparatus and connections. Only a few weeks ago, I travelled several hundred miles over a road which has practically all of its main sidings or passing places fitted with derails connected up to the switch. This, of course, requires a longer connection than from a switch to a frog. Of course the substitute, or "mechanical crossing," has its limitations, the same as the spring-rail crossing. It is not desirable for general use in yards, where quick switch throwing is necessary. For sidings in limited use, where the heavy wear of the crossings is out of all proportion to the actual duty performed in carrying wheels in and out of the siding, it would seem very desirable to have an unbroken main rail, and this appears to open a field for the mechanical crossing.

One of the first of these devices to be put into actual service is that patented in 1884 by Mr. Charles B. Price, now general superintendent of the Allegheny Valley Railroad. This device has a protector bar, fitted against the gauge side of the rail in such a position as to be operated by the wheel flanges. When it is pressed back by the flanges, its hooked lugs engage with sockets on the operating rod, which is thus locked so that the switch cannot be thrown until the last pair of wheels has cleared the crossing.

The MacPherson crossing is operated in connection with the MacPherson safety stub switch on the Canadian Pacific Railway. Up to last March, about 150 of these had been put in service in the Canadian Pacific Railway, and during four years' service they have shown but little wear, while the cost of maintenance has been very small, according to the testimony of officers of the road. When set for the siding it has been trailed through by a main-line train, and has been run through as a misplaced facing switch by an express train, without damaging the crossing or causing a derailment, in spite of the elevation.

The Coughlin swing rail crossing is on the same principle, but the lead wing rail does not move. The crossing rail is the only moving part, and is made of a piece of track rail, instead of being a heavy casting, as in the Price frog. This device is being tried by several railways. It is a pity that some practical arrangement of this sort cannot be devised for giving an unbroken rail at level crossings of railway lines at reasonable expense. The Fontaine crossing did effect this, but was expensive and in other ways unsatisfactory, and never came into more than experimental use.

Turning from the track itself, we may briefly consider the extensive introduction of metal as a substitute for wood for signs and fencing. Sheet iron signs or posts of angle iron or tubes can often be made economically from scrap material, or they can be purchased ready made. For wire fencing in a treeless country, the Burlington and Missouri River Railroad is using posts of old boiler tube set in concrete pedestals. These posts are made at the shops. The Page woven-wire fence has its longitudinal wires coiled spirally and then straightened out, thus forming a springy, wavy line which provides for all contraction and expansion.

In methods of handling and distributing material for raising and ballasting track, widening embankments, and filling trestles, great advances have been made, largely in the rapid handling of great quantities of material, thus greatly reducing the cost of the work. A steam shovel or excavator will beat the biggest and quickest gang of shovellers all to pieces in loading gravel on dump cars. In unloading, some means of automatic dumping and of regulating the quantity dumped are of great value. Under the old method the plough on the rear car is hauled along the train by the engine, which is uncoupled and run ahead, while all the brakes are set on the cars. This not only causes inconvenience and loss of time in handling the cable and doing the work, but it also practically requires the whole train load to be ploughed off at one place. With the "rapid unloader" a winding engine is mounted on the front car, taking steam from the locomotive. The cable for the plough is attached to the drum, and is carried back to the plough by attaching the end to a derrick arm beside the track, and then running the train ahead. A car load, or half a car load, can be ploughed off at any spot. By regulating the speed of the winding engine and of the train, the ballast or filling can be distributed in any desired quantity. No change in cars is required, nothing but the equipment of the first car and the steam connection to the locomotive.

Dump cars of various designs are now being used on this sort of work. The Goodwin cars are built of steel, and have movable sides and bottom, so hinged that the load can be dumped on one or both sides, or between the rails. They are operated by hand, or by air from the brake reservoir. Each car will hold nearly thirty cubic yards of ballast, and they are unloaded at speeds up to eight miles per hour.

To spread and level the ballast, "spreader" cars, fitted with hinged wings or gates, are sometimes used. In ballasting with the Rodger car the ballast is deposited in a ridge between the rails by hopper-bottom cars, and at the rear of the train is a flat car fitted with a scraper or plough. This throws a portion of the ballast out over each rail and levels it down, while flangers clear the rail and form a flangeway. The ties can then be jacked up and have the ballast shovelled and tamped under them.

One other class of work to which I will refer is that of filling trestles by the hydraulic method. Ordinarily, the work of filling, to replace the trestle by a solid embankment is done by shovelling or dumping material from construction trains. Both the Canadian Pacific Railway and the Northern Pacific Railway, however, have made use of the hydraulic system, which is cheap, and causes no obstruction to the track, though it is a somewhat slow process. The water is brought by pipes from an elevation, and is thrown in powerful jets against the hillside. The stream of water and gravel, or earth, is carried by a wooden trough or flume to the side of the bank, the end of the flume being shifted as desired. The water runs away, leaving the solid material behind, which forms a very close and compact bank. In order to prevent the waste water from carrying away the finer dirt which it carries, and to prevent it from cutting the slopes of the bank, a low dam of old sleepers, brush, marsh hay, &c., is kept built along the edge of the bank. This forms a shallow pool, in which the water lies at rest, depositing the sand, &c., and flowing gently over the top. The series of dams of old ties on the face of the bank or embankment makes it look as though the slopes were rip-rapped or paved. The great jet of water is thrown from a swivelling nozzle, 3in. to 4in. diameter, such as is used in hydraulic mining. A gang of five men with one nozzle can build 500 to 1500 cubic yards of bank per day, at an average cost of 3d. per cubic yard. The bank is built up in this way to within 3ft. or 4ft. of the formation level, and is then finished by means of construction trains.

In the construction and repair of trestles, docks, &c., and in the construction of temporary structures at washouts, a track pile driver is a most useful machine. In the large machines of this kind, built by the Industrial Works, the foundation is a 46ft. platform car with steel underframe. The horizontal frame which carries the vertical guides is carried by a turntable, so that it can be swung round to drive piles on either side of the track. The bed can be run forward so that piles can be driven 16ft. ahead of or on either side of the car. The leaders or guides can also be inclined sideways to drive brace or batter piles. An ordinary drop hammer is generally used, but some of the machines have steam pile hammers. The machine has its own engine and boiler. The engine can be used for hoisting and handling piles, and can be connected by gearing to the rear truck, so as to propel the machine at about five miles an hour. For transportation, the leader stays are unhooked at the top and fall forward, while the leaders fall backward, both lying in a horizontal position about 7ft. above the floor of the car.

A few large railways are using rail-sawing cars to cut off the ends of worn rails and drill new bolt holes, so as to make the rails serviceable for branch lines, sidings, &c. The car is of steel, and carries an engine and boiler, rail saw, one or two drill presses, rail straightener, and other appliances. Care is taken to match the rails as to height. The machine can handle between 400 and 500 rails per working day, at a cost of about 3s. per ton.

Now that the roadmaster is coming to be considered as an officer of greater importance, greater provisions are being made to facilitate his work, and on some roads he is provided with a gasoline car instead of a hand car. This gives much greater speed and facility in getting over the line on business or for inspection, without requiring men to be taken to propel the car.

* Abstract of an address delivered before the annual meeting of the Roadmasters' Association of America in September, 1899.

THE SOCIETY OF ARTS.

As already mentioned in our columns, Sir John Wolfe Barry, K.C.B., chairman of the Council of the Society of Arts, delivered his address at the opening meeting of the 146th session of the Society, on Wednesday, November 15th. His subject is a favourite of his, namely, the overcrowding of the London streets. He referred to his address at the opening of last session, and said that since it had been delivered the police had taken the step of prohibiting empty cabs from moving about in search of fares. This may be necessary in the general interest, but it certainly deprives Londoners of a former considerable convenience, and it has necessitated the establishment in many of the main thoroughfares of cab ranks, which are in themselves most objectionable, in that they have the effect of seriously narrowing streets already too narrow for the moving traffic. When one sees rows of stationary empty cabs of great and hitherto unknown length occupying the middle of such streets as the Strand, Oxford-street, Queen Victoria-street, Pall Mall, Victoria-street, St. James's-street, and Piccadilly—streets which are only of very modest widths—one cannot but recognise that the mere fact of these obstructions, which have been allowed in lieu of "crawling cabs," is evidence itself of the fact that our streets cannot accommodate the traffic which desires to be moving in them.

Sir John pointed out in this connection that the width of a street is not to be judged of by merely considering the number of vehicles to be passed along it. It is valuable in a chief degree in order to permit of differences of speed. Thus, for instance, placing a cab-rank in Queen Victoria-street, for almost the whole distance from Mansion House to Cannon-street, though it may still permit of four rows of moving vehicles, takes away a most important convenience in removing any facility for the inner rows of traffic adjusting differences of speed, and, in fact, makes the street 12 per cent. narrower, and probably 25 per cent. less effective. Such being the condition of things with a population of Greater London of 6,000,000, the question may well be asked, What will be the traffic thrown on our streets in the next thirty years, at which time it has been estimated by competent authorities that the population may be doubled, and reach the enormous total of 12,000,000?

He remarked that it seemed almost unnecessary to admit that in such a city as London any radical cure for evils which have been allowed to accumulate must involve heavy expenditure. On the other hand, he proceeded to point out how large the financial issues are on the other side. He proposed to discuss, first, the estimated cost of the new and widened streets suggested, and of the crossings of east and west and north and south traffic, by means of bridges over or under the streets, at six of the important places of intersection:—Hyde Park-corner, Piccadilly-circus, Ludgate-circus, Oxford-street and Tottenham Court-road, Wellington-street and Strand, Southwark Bridge-road and Upper Thames-street. In approaching the figures of the estimated cost, stress was laid upon two very important points. First, that the net cost of such works is conditioned by the time given for the realisation of the properties forming the frontages of the new streets when made, and of surplus property adjoining them. Secondly, that the cost of the streets, however high, may be amply justified by the money saved to the public by improved means of locomotion.

The great thoroughfare, 125ft. wide, from west to east of London, already advocated by Sir John, would, with subsidiary connections, be 5$\frac{1}{2}$ miles in length, and though no doubt much of the property is very valuable, yet a large proportion of it is residential property, not of the very highest class, where no trade interests have to be bought. On the other hand, in some portions, especially at the eastern end, the first cost of purchase of the sites would be very high. On the whole, he should imagine—and was fortified in this by the opinion of one of the first land valuers of London—that, after making an allowance for the greater width, the new street would not compare, yard for yard, unfavourably with the street from Holborn to the Strand, from Wellington-street to St. Mary-le-Strand, and involves the compulsory purchase of four theatres, and the great building occupied by the offices of the *Morning Post*, the whole undertaking being four-fifths of a mile in length. If this mode of estimate be permissible, we should see that the net cost of the new street from east to west through London, assuming that the ground rents were sold at once, would be £5,750,000, and that if the ground rents were retained for sixty years, the street could be made without any ultimate financial burden on the ratepayers.

As to whether it would relieve the traffic of existing thoroughfares, and make provision for the wants of the future, he ventured to think the matter might be left to the judgment of the public, who seldom go wrong on such matters. It seemed to him unreasonable to question its utility.

The block in the Strand, when the Embankment is under repair, was mentioned, and on the other side attention was drawn to the effect of widening Parliament-street lately to a width of 125ft. There was not much difficulty in realising what a boon such a street extending from Bayswater to Whitechapel would be to the traffic of London.

Since last year he had looked more carefully into the circumstances, and had laid down the lines of the works already mentioned.

(1) *Hyde Park Corner.*—In this case the west and east traffic would pass under the stream going north and south by means of a broad sunken road, leaving the Knightsbridge road on the north side, and rejoining Piccadilly on the south side. A strip of land of an area of 3·1 acres would be required from Hyde Park and from the Green Park, and practically no buildings would be affected. It would consequently be a cheap undertaking.

(2) *Piccadilly-circus.*—This is a much more difficult and a highly expensive work. The north and south traffic would cross under the west and east traffic by means of a central sunken road descending from the north end of the Regent-street quadrant opposite Vigo-street, passing under Piccadilly-circus, and emerging in the Haymarket, the portion under Piccadilly-circus and Coventry-street being in tunnel for a length of some 180 yards, with openings for light and air.

(3) *Ludgate-hill.*—In this case the north and south traffic would be crossed over the east and west stream by means of low viaduct and bridge. The natural way of dealing with this crossing would be to cross the east and west lines over the north and south, as the gradients of Fleet-street and Ludgate-hill lend themselves to that arrangement, but this was set aside as too expensive.

(4) *Oxford-street and the south end of Tottenham Court-road.*—At this place the west and east traffic would cross over Tottenham Court-road on the north side of Oxford-street. The properties are not extremely valuable, as it would be possible to avoid the Oxford Music Hall and other important buildings fronting Oxford-street by keeping the new high-level road about 150ft. to the north. The gradients might involve the raising of the level of Oxford-street opposite Rathbone-place some 2ft. or 3ft., otherwise no considerable difficulties would be encountered.

(5) *Wellington-street, Strand.*—In this case the crossing ought to form part of the present scheme of the London County Council for their new street to Holborn, if it is to be a really successful work. The gradient of Wellington-street clearly indicates that the north and south traffic should pass over the Strand. With the exception of the Lyceum Theatre, the property is not specially valuable. The County Council do not think much of theatres, for they are going to acquire, as above indicated, four in connection with the street to Holborn and Strand improvement. The crossing street would ascend from the corner of Tavistock-street and Wellington-street by easy gradients, keeping to the west side of the latter street, and descend by a grade of 1 in 30 to rejoin Wellington-street at the north end of Waterloo Bridge.

(6) *The passing of the north approach of Southwark Bridge over Upper Thames-street.*—This is a work which speaks for itself, and presents no serious difficulties. The crossing street would con-

tinue the level of the north end of Southwark Bridge, and would be parallel to and to the east of Queen-street, descending to rejoin the existing level at the corner of Cannon-street and Queen-street.

Having, then, laid the foundation by estimating the cost of the improvements on the north side of the Thames, suggested for consideration, the second of the main questions is reached, viz., What is the money which would be annually saved by the inhabitants of London by improved means of communication? An estimate, made over thirty years ago, stated that a loss of from £400,000 to £500,000 a year was sustained by Londoners in the difficulties under which the coal trade alone lay, in consequence of restrictions under which it was necessary to place it. Now, we know that the coal trade, large as it is, forms only a part of the carted trade of London. The coal trade is but a small percentage of the whole goods and merchandise brought into London. Most of us are acquainted, for example, with the restrictions placed on the carting of building materials or the removal of excavations.

If the estimate of the coal trade should now be taken as £450,000 a year, it seemed quite permissible to double it so as to include other trades, and we so reach a sum of £900,000.

Sir John then referred to certain statistics which he had obtained as to delays to all descriptions of traffic. He found that in one hour the following number of vehicles and pedestrians passed a given spot :—

	Vehicles.	Pedestrians.
Cheapside	992	6358
The Strand	1228	5660
Piccadilly	1497	3910
Tottenham Court-road	661	5586

It is to figures such as these that delays occur. By another enumeration it was found that in an hour the following number of omnibuses included in the above figures pass a given spot :—

Cheapside	384
The Strand	444
Piccadilly	423
Tottenham Court-road and Oxford-street junction	487

We may thus assume that, on the four routes in question, we have to deal with an hourly traffic during the working part of the day of 1750 omnibuses, 1500 cabs and carriages, and 1000 carts. There is, of course, much difference between different parts of the day in respect of the overcrowding of traffic—the amount of delay which it occasions. He did not think we should be far wrong in taking an average of nine hours per day—say from 9.45 a.m. to 6.45 p.m.—as the period during which three of the routes mentioned are overcrowded, and in the case of Piccadilly, a period of eleven hours, recognising that the amount of overcrowding is by no means uniform during the hours in question. Thus we arrive at the fact that on these four routes only each day 16,650 omnibuses, 14,900 cabs and carriages, 9700 carts and other vehicles find their course impeded and delayed by the crowded state of the streets.

The absolute amount of retardation is a matter of estimate from observation, and presents some difficulty. He had had the time taken of vehicles in crowded and less thronged and free parts of the main thoroughfares; and found that the amount of retardation in different parts of the four main streets alluded to varies from 10 per cent. to 44·8 per cent., as compared with the speed in unimpeded parts of the street.

After a series of observations as to the speed of traffic in impeded and unimpeded streets he thought that it was under-estimating the retardation due to overcrowding to put them at 20 per cent. on the four routes in question, which is equivalent to saying that one allows four minutes additional on a journey which, if the streets were as wide as Whitehall, would occupy twenty minutes. At any rate, taking for calculation 20 per cent., to what does it amount in money for the loss of the time of the vehicles and passengers? The value of the time of the vehicles and driver can be pretty nearly arrived at, and he assumed in this respect 4s. per hour for an omnibus, 2s. 6d. per hour for a cab, and 2s. an hour for a cart. We then have the passengers, and he took ten passengers in each omnibus at 9d. per hour, 1½ passengers per cab, and private carriage at 3s. per hour. Similarly, when a working man's time is valued at 1s. per hour, the estimate for the omnibus passengers does not seem high after making allowances as before.

From these figures it would appear that the hourly traffic in the four streets in question involves £1631 per hour. If this is delayed 20 per cent., it means a loss, in respect of vehicular traffic only, of £880,740 per annum. There remains to be added the traffic of the Euston-road and Queen Victoria-street, if we are to include the chief east and west routes, and perhaps these may be taken at about 15 per cent. of the above figures. We have also to include the traffic which crosses these four chief routes, and is there greatly delayed, and this, he thought, might be taken at about 20 per cent. of the above figures of the east and west streams.

In addition to vehicular traffic we have pedestrian traffic to consider. Applying the same mode of caculation as above, and from observations taken, he came to the conclusion that this traffic—21,514 individuals in all, per hour, in the four streets under consideration—is delayed to the extent of one-third of the delays to vehicular traffic, or, say, 6·6 per cent.; and if we assume a value per hour of 4d. per individual, allowing for females and non-wage-earning persons, we arrive at an annual loss of £65,000.

To sum up, therefore, we arrive at an annual loss on the various routes above discussed of—

	£
Trade interests	900,000
Vehicular traffic	1,189,000
Pedestrian traffic	65,000
	£2,154,000

He did not pretend that these figures could be more than an attempt to put before his hearers in money value the daily and hourly inconvenience which Londoners sustain by narrow, overcrowded streets.

That a very large amount of money is being wasted will not be denied, nor can it be doubted that whatever the loss may be it is getting worse and worse every year. But neglecting this consideration, and capitalising the present loss, whatever its true figures are, at thirty years' purchase, we can see that many more millions of expenditure in improving the facilities for traffic on the north side of the Thames would be commercially justifiable.

Again, then, he entered his plea for a systematic consideration of this great subject as compared with hand-to-mouth attempts to cure isolated evils when they become too intolerable. Let us not fold our hands or allow our representatives to persuade us that all is for the best in London. We want a large-minded plan for dealing with admitted evils, a plan to be worked to gradually, and one which, when realised, will really accommodate our present and future traffic, and be a credit to the metropolis of Greater Britain.

AUSTRALIAN NOTES.

(From our own Correspondent.)

Victorian railways.—The annual report of the Commissioner on the working of the Victorian railways for the year ending June, 1899, shows a considerable improvement on the previous year's results, and bids fair to make the railways a valuable acquisition to the Colony.

A contract for ten passenger engines has just been let, and an Act passed for the provision of fifteen goods engines. It is suggested that provision should be made this year towards replacing fifty of the older and smaller type of engines by fifty engines of modern type.

The locomotive branch working compares with the previous year's working as under :—

	Year 1898-9.	Year 1897-8.
Average miles open	3,122	3,123½
Train miles run	9,714,298	9,239,657
Engine miles run	12,657,886	11,920,974
Locomotive working expenses	£633,422	£571,106
Locomotive working expenses per engine mile	1s. 0·01d.	11 50d.
Number of men and boys employed on 30th June :—Permanent	2,674	2,718
Casual	398	334
Cost of coal and wood per train mile	3·29d.	2.96d.
Total cost of fuel for locomotive running	£133,179	£113,730
Cost of oil, tallow, and waste for running engines	£6,807	£6,537
Ditto per train mile	·17d.	·17d.

Referring to the article that appeared in the pages of THE ENGINEER a short time ago on the proposed North Sydney bridge, without expressing any opinion on the merits of the various schemes, it is well to state the various views expressed. In the year 1896 three Bills were before Parliament. Mr. B. C. Simpson, the promoter of one of the bridges, proposed to construct a bridge from Dawes' Point to Milson's Point, having two spans of 550ft. each, with head room of 160ft., and designed to carry tram, vehicular, and foot-passenger traffic. The cost is estimated at £400,000, including land resumptions; the Government to have the power to purchase the bridge after twenty-one years.

Mr. Kenwood, the promoter of the other bridge proposal, suggested the same route, but his 1896 scheme was for a bridge of three spans, the centre span being 664ft. wide, with head room 160ft. from high water. This bridge, 60ft. wide, is also designed for tram, vehicular, and foot-passenger traffic; the Government to have the right to purchase after thirty years. Mr. Norman Selfe has also suggested several schemes for connecting the two shores, but his schemes have not yet been brought within the range of practical observations.

Mr. John Sulman is the promoter of two tunnel schemes, one for vehicles from Circular Quay to Milson's Point, and the other for passengers from King-street to Milson's Point, the cost of the latter being estimated at £300,000. In July and August, 1896, these schemes were brought before the House and referred to a Parliamentary Committee. Mr. Sulman afterwards reduced his schemes to one passenger tunnel, and puts the cost of one electric railway tunnel and the roadway tunnel at £600,000, the time before Government resumption to be twenty-five years. Mr. Kenwood proposed to alter his scheme by substituting a bridge of two spans, with only one pier in the harbour instead of two, with a headway of 180ft., along 325ft. of the centre of each span, but considers it unnecessrily high, and the extra cost involved would be close on £100,000. Mr. Simpson has at present a Bill before Parliament, in which an alteration has been made to construct a bridge having one large span of 1300ft., giving a headway of 180ft. high, along 600ft. in the length of the span, the roadway of the bridge to be 60ft. wide, and to carry a double line of tramway The route to be from near the end of Prince's-street *viâ* Dawes' Point, and across the water to M'Mahon's Point, thence to Blue's Point-road. Through the apathy of the Government in neither taking the matter in hand departmentally, nor in Parliament passing a Bill allowing private enterprise to take the matter up, a people's league has been formed at North Sydney, when pressure will be brought to bear to upset the vested interests working in opposition to the carrying out of one or other of the schemes.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

More monster locomotives.—The Delaware, Lackawanna, and Western Railroad is among the latest additions to the long list of railways which are now introducing engines of exceptional size and power in order to reduce transportation expenses by increasing train loads and reducing train mileage. This road passes through a great coal region, and has an enormous coal traffic, while along its line are great banks of culm or refuse coal available for fuel under certain conditions. To handle the traffic and utilise this cheap fuel the company has put in service fifteen locomotives of the twelve-wheel type, having eight driving wheels, and a four-wheeled leading bogie truck. They weigh 91½ English tons, with 74 tons on the driving wheels, or 140 tons with the tender. They burn the light dusty coal, there is a huge fire-box with a great area of 82½ square feet, the arched crown sheet stayed by radial stays. Piston valves are used, and a plain cylindrical funnel. The cab is forward of the firebox and the second driving axle is the main axle. The tender has two four-wheeled bogies. The leading dimensions are as follows :—

Cylinders	21in. × 32in.
Driving wheels	4ft. 6in.
Driving wheel base	15ft.
Total wheel base	25ft. 9½in.
Piston valve, diameter	1ft.
Steam ports	2½in. × 25in.
Exhaust ports, minimum area	110 sq. in.
Boiler, diameter of barrel	6½ft. to 7½ft.
Boiler pressure	210 lb.
Fire-box, size	8ft. 1in. × 10ft. 3in.
Tubes, 410, diameter	2in.
Tubes, length	13ft. 10½in.
Grate area	82½ sq. ft.
Heating surface, tubes	2050 sq. ft.
Heating surface, fire-box	218 sq. ft.
Heating surface, total	2168 sq. ft.
Smoke-box, length	5ft. 7½in.
Exhaust nozzle, single, diameter	5½in.
Funnel, diameter	15½in. to 17½in.
Funnel, height	2ft. 6½in.
Rail to centre of boiler	9ft. 2½in.
Rail to top of funnel	15ft. 1½in.
Length of connecting-rod	8ft. 2in.
Inside laps of valves	1in.
Lead of valve in full gear	¼in. negative

Tender.

Wheels	2ft. 9in.
Length and width	21ft. 8½in. and 10ft. 6in.
Coal carried	10 tons
Water carried	5000 gallons

Marine notes.—The American Shipbuilding Company, which controls a majority of the shipyards on the Great Lakes, and three independent yards, is building twenty-five steel vessels for next year's service. One is a passenger and excursion steamer, four are large barges to be towed as consorts, and twenty are cargo steamers. Five of the steamers will be 500ft. long. The combined cargo capacity is 150,200 gross tons. Two passenger steamers are to be built to run between Detroit and Buffalo, on Lake Erie, and are to have a regular running speed of twenty-two miles per hour. Another steamer, the Porto Rico, has been built on Lake Erie for the West Indian service, and will be sent down the St. Lawrence. She will not run the rapids as the other boats did, but will go through the new Soulanges canal on the Canadian side. The steamer is 220ft. long, 32ft. beam, and 21ft. deep, and will be driven at a 15-knot speed by a triple-expansion engine, having cylinders 18in., 27in., and 45in. diameter, and 30in. stroke. A stern-wheel steamer is being built at the Trigg yards for missionary service on the Congo River. She is 70ft. long, and 13ft. beam, with a 70-horse power engine designed to give it a speed of 10 knots to 12 knots. She will be shipped to Africa in sections. The United States Navy will have a fleet of thirty-five torpedo boats and sixteen torpedo-boat destroyers when the vessels now being built are completed. Five are being built on the Pacific coast. Most of them are being built on the Navy Department plans, but some on special or modified plans. Liquid fuel is to be used on some of the boats. They are of various sizes, and are guaranteed for a speed of thirty miles per hour, while one has made a record of thirty-one miles. The troopship Thomas, recently built at Cramp's yards, has a very complete equipment, including an ice-making plant of two tons daily capacity, and an apparatus capable of converting sea water into filtered fresh water at the rate of 10,000 gallons a day.

Steel works.—A large steel foundry and steel forging plant are to be built as an addition to the extensive works of the Westinghouse Machine Company, at a cost of about £250,000, and will have a combined capacity of 80 tons of castings and forgings per day. The foundry will have a steel-framed building, 400ft. long and 200ft. wide, with two modern 40-ton basic open-hearth steel furnaces and a complete casting plant of the most modern construction. The forging shop will be 400ft. long and 150ft. wide, connected with the foundry. It will make forgings up to 20 tons in weight, and the equipment will include hydraulic presses and steam hammers of the largest size. The Carnegie Steel Company will build at Rankin two new blast furnaces, 106ft. high and 24ft. diameter at the bosh, with a capacity of 1400 tons of Bessemer iron daily. Contracts have been placed for the furnaces and the blowing engines, and also for a new blooming mill at Duquesne. A bridge will be built across the Monongahela River to carry hot metal from the Cattie furnaces to the Homestead Works. At Bessemer, six blowing engines are to be replaced by eight engines of nearly double the capacity. In the aggregate, the capacity of the company's entire plant will be increased to 3,000,000 tons of finished material per year. A new system of armour-plate manufacture is being introduced by the Holzer Steel and Iron Process Company. The process is strictly secret, but is rumoured to include some form of electrical treatment. Tests on a small scale have been made with test bars, 3in. long and ½in. diameter, and the highest results obtained are as follows :—

	Untreated bar.	Process No. 1.	Process No. 2.
Tensile strength, pounds	68,000	71,600	70,800
Elastic limit, pounds	39,000	51,000	51,000
Elongation, per cent.	29·33	26·33	27
Reduction of area, per cent.	63·65	63·65	64·68

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

DURBAN, October 27th.

THE war which is now being waged between England and the Transvaal should have the effect of drawing attention to the vast improvement which harbour works have effected in the approaches to Durban Bay. The building of the north pier extension has given a regular minimum depth of at least 20ft. over the bar at low tide, and this has now been maintained for some weeks past without dredging. This result is certainly a triumph for expert engineering opinion over the views of practical men. The north pier is, however, only part of the works suggested by the engineers, and it was only agreed to as an experiment by the advocates of dredging. Its success will probably lead to an agitation for the completion of the whole scheme. Durban's ambition is to secure a harbour entrance 30ft. or 35ft. in depth, so that the largest British battleships could come inside at all states of the tide. If this were provided, the port might have some chance of becoming a naval station, and an enormous impetus would, of course, be given to the coal industry of the Colony.

Electrical transmission of power has been making little progress on the Witwatersrand lately. Yet the results obtained, especially in pumping from the deep levels, have been of the most satisfactory character. Besides the big central plant at Brakpan there is a smaller distributing station for the Simmer group of mines. This concern is now supplying electrical power at 1·9d. per unit, and that figure is likely to be further reduced when induced draught has been fitted to the boilers. The plant consists of three 700-kilowatt generators, of Swiss make, driven by Allis Corliss engines. In view of the controversy which has arisen concerning the employment of American engines in British electric tramway equipments, it may be of interest to note that these engines have worked most admirably under the tremendously variable loads which the character of the work done throws upon them. The current is three-phase, conveyed at a tension of 3600 volts, and it is proposed to employ rotary converters in order to adapt it for the working of underground locomotives. With this plant, as with others on the Rand, strenuous attempts have been made to utilise electrical energy for the working of rock-drills, but entirely without success. One curious feature of the installation is that all the poles carrying the electric wires are painted with a death's head and cross-bones. This is done by order of the Pretoria authorities, and is intended as a precaution against accident.

A good deal has been said and written of late concerning the prompter execution of machinery orders by American firms than by their British competitors. There are several sides to this question, however. One was illustrated the other day in the experience of a Rand mining concern which has ordered half a dozen boilers from American makers. When these arrived they were found to be entirely useless, as the boiler inspector refused to pass them, and, in fact, they would not stand more than 20 lb. pressure of steam. Certainly no British firm would have allowed such defective boilers to leave its works.

Business of all kinds, and particularly the trade in machinery and engineering requisites, is, of course, paralysed during the war. However, everybody is agreed that as soon as the struggle is over there will be a "boom" in South Africa, such as has never before been experienced. No one can doubt that the political unrest in the Transvaal has been choking the country like an old man of the sea for the past four years. The war will, at all events, remove this obstacle to progress, and leave a clear course open for the industrial advancement of South Africa.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE period of money-making for those engaged in iron and steel manufacture is by no means over. Prices are very firm. Northampton pigs are gone up to 72s. and 74s., and some makers ask 75s. Derbyshire producers quote about the same prices as these, whilst Leicestershire descriptions command about 73s. to 76s. There is a good demand for hematites, notwithstanding that mixed numbers are now quoted at as high as 90s. In all departments of the pig iron trade, however, makers are endeavouring as far as possible to restrict their supplies to the immediate requirements of consumers, since they look forward to being able to ask higher prices in a few weeks' time. Common forge iron is 68s. 6d. per ton, and part-mine is in good demand at from 75s. to 76s. 6d.; while as to hot-air iron, 85s. to 90s. is quoted for forge sorts, and 95s. for strong foundry. Part-mine and common are the descriptions which seem chiefly to be moving, though there is a decidedly satisfactory call also for cold-blast pigs for chilled roll-making and for other high-class foundry work.

High prices and good demand continue to characterise the manufactured iron trade. Galvanised iron is quoted £14 10s. for 24 w.g. delivered Liverpool, whilst £9 15s. to £10 is asked for black sheets (doubles), most makers insisting upon the higher figure. Common bars remain £9 10s. and marked bars £10. There is a large demand for the best iron of the "list" houses, a great deal of heavy forging work being in hand in the district. Gas tube strip is in good inquiry at £9 10s., and a steady trade is doing in stamping sheets at £10 10s. to £11.

The engineering demand for steel continues good, last week's prices being well maintained.

The free offering of American copper has been a feature of the copper market lately at lower prices than previously. Electrolytic copper has also been offered to English and continental consumers at £76 net c.i.f., or equal to about £80 per ton, Birmingham terms. Best selected ingots continue scarce, and sell at about £80 to £80 10s. per ton, but their place is being taken to an increasing extent by electrolytic plates, which also sell at £80 10s. per ton delivered in the Midland metropolis.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The extraordinary industrial and commercial activity throughout all branches of the engineering and iron trades continues in full flood, and there are no indications that the high-water mark is yet being reached. In one or two sections of engineering, as I have previously noted, there are signs of slackening, chiefly amongst textile machinists, who, for some time past, have been running out their order books more rapidly than they have been filling up with new work, whilst here and there heavy stationary engine builders are not quite so pressed as they have been. These are, however, isolated cases, and taking the engineering trade all through, new work is not only coming on the books in ample quantity to keep up the present exceptional briskness for a considerable time forward, but in some quarters the new work offering is in excess of what makers can deal with, except for long deferred delivery.

This is the position of many of the special machine tool makers, and as an illustration of how under similar conditions they do things differently in America, it may be interesting to repeat a statement made to me on 'Change, that American machinists, where they cannot undertake the delivery of any particular tool, say within six, nine, or twelve months, decline to bind themselves to any fixed price; they will contract to deliver on some specified date, but the makers are themselves then to fix the price they will charge for it. Something like this has been attempted in the Lancashire coal trade, colliery owners having inserted clauses in their contracts to the effect that while they will deliver certain quantities at specified dates, the price at the date of delivery is to be fixed by the current market rates then ruling. The merchants, however, have fought shy of contracting under such conditions; and it is questionable whether English machine toolmakers would find their customers at all likely to submit to American methods in matter of the price they might be required to pay when deliveries were made.

The Manchester Iron 'Change meeting on Tuesday was perhaps to some extent unsettled by the con .erable drop in both Middlesbrough and Scotch warrants, which, I believe, was mainly due to reports received from the United States that a cessation of further buying had become noticeable there. The easing down in warrants, except possibly giving some check to buying, had, however, no appreciable effect upon the Manchester market, and so far as both makers' and manufacturers' prices were concerned, they were not only fully maintained, but generally the tendency was in a further strong upward direction. In pig iron steady buying was reported, although not in large quantities. Foundry qualities are quoted by local makers 78s. 6d., less 2½, as the minimum, and this figure is being readily got for the small quantities they have to sell; Lincolnshire makers are now holding out for 76s. 6d. net, and this figure has also been got; Derbyshire brands can only be quoted nominally about 80s. net delivered Manchester. For forge descriptions higher prices are being quoted; Lancashire brands average about 76s., less 2½; Lincolnshire makers have declined to book further orders at 74s. 2d., and are now asking 75s. 2d. net delivered Warrington. For Middlesbrough and Scotch brands offering here prices are somewhat irregular, although generally they show an advance over last week. Ordinary foundry Middlesbrough averages about 78s. 10d. to 79s. 4d., with some makers now quoting 80s. 4d. net by rail Manchester. Eglinton and Glengarnock, delivered Manchester docks, average about 81s. 6d. to 82s. in the open market, with makers quoting 83s. net, and American pig iron 78s. 6d. per ton net cash.

In the finished iron trade exceeding activity prevails throughout all branches. Notwithstanding a further strong upward move in prices, makers report that buyers are coming forward more freely than ever, and in most cases they are compelled to decline a very large weight of orders, owing to their being already so heavily sold far into next year. A very prevalent complaint, however, is that the men at the forges are working but indifferently, and that the output is consequently not up to the average, whilst the fuel question is becoming a serious matter, as not only are prices for some descriptions 50 or even 75 per cent. higher than at this time last year, but supplies, especially of slack and coke, are becoming very difficult to obtain. On Tuesday the Lancashire Bar Makers' Association raised their list basis 5s. per ton, the minimum of quotation being now £9 10s., this figure having already been freely got on business put through recently. For North Staffordshire bars the nominal basis remains at £9 10s., but makers are not booking new business at this figure. Sheets have also been advanced, Lancashire makers now quoting £11, delivered here. The Lancashire Hoop Makers' Association has raised list rates 5s. per ton, bringing quotations to £9 17s. 6d. for random, to £10 2s. 6d. for special cut lengths delivered Manchester district, and 2s. 6d. less for shipment. Lancashire finished iron makers also report that in tubes they are doing an extraordinarily large trade, not only on home accounts, but with continental users, who are keen buyers, and prices for this class of material are consequently hardening up to a similar extent with other goods.

Prices both for raw and manufactured steel continue to stiffen up, although any really quotable advance is not so general as in the iron market. For hematites the minimum quotations have been raised 1s. per ton, average figures for No. 3 foundry, delivered here, being now 90s. 6d. to 93s., less 2½. Local makers are very firm at £7 net as the minimum for billets, and £9 for ordinary basic steel bars, with plates ranging from £9 for ordinary tank qualities to £9 10s. and £9 12s. 6d. for boiler-making descriptions, with hoops quoted £10, delivered Manchester district.

Nut and bolt makers, although they have not yet followed the further advance in finished material, by a similar corresponding upward move on their list rates, are not unlikely to do so, and in the meantime are quoting above their list basis for new business now coming forward.

In the metal market the only change to note is that condenser plates have been reduced ¼d. per lb.; other descriptions of manufactured goods remain firm at recent rates, and there is an active demand for boilermakers', locomotive, and general engineers' requirements.

No really material change can be reported, for the present at least, in the general position throughout the coal trade of this district. The better qualities have been meeting with rather more inquiry, due, no doubt, to anticipations of an advance in prices for next month; but there is still an absence of any actual pressure of demand, and if collieries were working to their full output, a considerable quantity would no doubt just now be going into stock. The men, however, continue to work indifferently, and, although nominally putting in full time, their output is scarcely more than equal to a four and a-half days' "get," with the result that stocks are not being increased to any appreciable extent. Prices for the present month remain very firm at the full list rates of 12s. 6d. to 13s. 6d. for best Wigan Arley; 11s. to 11s. 6d. for Pemberton 4ft. and seconds Arley; and 10s. 6d. for common house coal at the pit. The exceptional activity which is maintained throughout the iron and engineering trades is keeping up correspondingly large requirements for all descriptions of common round coals suitable for steam and forge purposes, the output of which is moving away freely, and at many collieries is short to meet the demand. Prices tend steadily in a hardening direction, and on current sales the minimum rates are about 10s. to 10s. 6d. at the pit, with advances on these figures quoted for forward delivery. The difficulty as regards supplies of slack would seem to increase, and it is only in very exceptional cases, due either to the out-of-the-way position of the pits or the quality of the fuel, that collieries have not business offering largely in excess of their present production. In many cases it is more than they can do to meet the requirements of their regular customers, and there is so very little slack to be bought in the open market, that all sorts of special prices are quoted to outside buyers; and for contracts for next year as much as 8s. 9d. to 9s. has been got in some instances. The current pit quotations are exceedingly strong at 6s. to 6s. 3d. for common, 6s. 9d. to 7s. for medium, and 7s. 3d. to 7s. 9d. for best sorts. For shipment an increasing demand is reported, with higher prices being got, 11s. 6d. to 12s. being now generally quoted for steam coal delivered ports on the Mersey or Manchester Ship Canal.

The chief question that has engaged attention during the past week, both amongst coalowners and merchants and consumers, has been the extent to which prices are to be further advanced with the close of the month, to which I have made reference in previous notes. At a meeting of the West Lancashire coalowners held in Manchester on Tuesday there was a strong feeling in favour of further advancing all descriptions of fuel 1s. 8d. per ton, and a proposal to that effect was put forward, but in view of the continued slackness in the house-coal trade this was modified to an advance of 10d. per ton on round coal and 1s. 8d. on engine fuel, and unanimously agreed to, subject, however, to an arrangement being arrived at with the colliery owners in the Manchester district for a similar upward move on their part. Whether it will be found possible to secure sufficient unity of action to carry out a further upward move of 1s. 8d. on engine fuel, which has already been advanced 2s. 6d. per ton over last year's rates, is perhaps doubtful, but that there will be at any rate a general all-round advance of 10d. per ton may be taken as practically certain, whilst it is not at all unlikely that, even in the event of the advance of 1s. 8d. on slack not being agreed to by the leading Manchester colliery concerns, some of the West Lancashire collieries will put up their prices to this extent, as they are strongly convinced that, in the present state of the market, and with the shortness of supplies, engine fuel will fully stand an advance of 1s. 8d.—in fact, better than round coals will stand a further advance of 10d. per ton.

With regard to coke, no quotable change is at present being made in list rates, but makers have to decline a good deal of business that is being offered in excess of their production, and prices are very strong at about 28s. for good foundry cokes, and 21s. to 22s. for ordinary qualities of furnace cokes at the ovens.

Barrow.—The hematite pig iron trade is very strong and firm, and makers are exceedingly busy, but they have very little iron to sell, and even merchants are short of supplies. The only weight of metal to deal with is that held in stores, amounting to 216,190 tons, the reduction in stocks during the week having been 1380 tons. This means an increase of 40,211 tons since the beginning of the year, and holders of warrants are now getting their harvest. Prices have been up to 79s. 11d. net cash sellers, but are now quoted at 78s. 7½d. net cash sellers, 73s. 7d. buyers. Makers are quoting 80s. per ton net f.o.b. for mixed Bessemer numbers, but this price is only nominal, as there is not much chance of business when makers are so well sold forward. There are forty-seven furnaces in blast, as compared with forty in the corresponding week of last year.

The iron ore trade is very steady, and business is well maintained, but raisers cannot deliver all the raw material on order, and Spanish supplies are still coming in very freely. Native sorts are quoted at 14s. 6d. to 15s. 6d. for good average qualities, and best descriptions are up at 19s. per ton.

The steel trade is exceptionally busy, and makers report a brisk inquiry for all sorts of steel. Orders are very plentiful for rails on home, colonial, and foreign account, and the price of heavy sections is firmly held at the advance of £7 per ton, light sections being at £7 10s. to £8. There are prospects of a very large business in the steel rail trade. Orders are coming very freely to hand for steel shipbuilding material, and it is evident builders are likely to require large supplies for a considerable time to come. £8 is the current quotation for steel ship-plates, and £9 5s. is the quotation for boiler plates. A very active market is experienced for general steel products, and all the mills are very busy.

Shipbuilders and marine engineers are doing a very large business, and they have good orders on offer from a large number of owners. There is reason to believe that so soon as builders have got a little further on with the work they have on hand they will accept some of the important orders on the market.

Coal and coke are brisk, at improving prices.

Shipping is fairly well employed at West Coast ports. Last week 12,010 tons of pig iron, and 6116 tons of steel were exported, as compared with 14,134 tons of pig iron, and 10,036 tons of steel in the corresponding week of last year. The aggregate shipments this year have reached 462,265 tons of pig iron, and 431,648 tons of steel, being a decrease of 6986 tons of pig iron, and 37,113 tons of steel, as compared with the corresponding period of last year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THERE is already some movement with a view to placing contracts for locomotive fuel for next year. Several railway companies are reported to be opening negotiations for fresh supplies on the expiration of present arrangements, amongst them being the Midland Company, which last year left the South Yorkshire Coalfield on the ground that the prices asked were excessive. It is understood that the terms will be made on the basis of 10s. 6d. per ton for best Barnsley hards. That figure was decided upon this year, but the companies did not succeed in getting it. There ought to be no difficulty in securing the figure in the new contracts, for the market is exceptionally strong, the stocks at the pits practically nil, while both inland and export demand is heavy. In addition, the German "combines" have resolved upon increased price-lists for next year.

In house coal the chief difficulty has been in obtaining wagons to move the output. Best Silkstones are now at 11s. to 11s. 6d. per ton; ordinary sorts, from 10s. per ton; Barnsley house, 10s. 6d. to 14s. per ton; seconds, from 9s. 6d. per ton; house nuts, 8s. 6d. to 9s. 6d. per ton. Householders will do well to secure their winter supplies at once. Winter quotations were maintained all the summer. An advance was imposed in October, a second in November, and a third is certain in December.

Steam coal is much firmer in spite of the season. This is chiefly owing to the railway companies generally buying in excess of their contracted tonnage, while the requirements of the iron trade are unusually heavy, and a greater tonnage than is customary at this season of the year is going to Hull and other Humber ports. Barnsley hards make 11s. per ton; seconds, from 10s. to 10s. 6d. per ton. These figures, exhibiting an advance of 1s. per ton on the week, are not to be compared with the upward bound at Cardiff, where steam coal has gone up from 12s. 6d. to 18s. 6d. per ton. In gas coal 11s. 6d. per ton is now quoted, this being 5s. per ton more than at the corresponding period of last year. These advances, too, do not check demand, for the call is greater than ever. Coke for blasting purposes is freely sold at from 20s. to 22s. per ton.

Engine fuel keeps as brisk as ever. Engine nuts, 8s. to 8s. 6d. and 9s. per ton: screened slack, from 6s. 6d. per ton; pit slack, from 4s. 9d. per ton.

In iron there are similar advances. Hematites are at 91s. to 95s. per ton, according to brand; common forge iron, 71s. to 72s. per ton, both showing an advance of 1s. on the week. Common bars have gone up 10s. per ton this week, the price now being £9 10s. per ton. Manufacturers of Bessemer and Siemens steels have put up prices another 5s. per ton, Bessemer steel being now from £8 15s. per ton upward, and Siemens steel £9 15s. to £12 15s. per ton, according to temper and quality. Here, again, the increased quotations do not discourage trade; they encourage it. In many branches of the crucible steel trade, as well as in open-hearth steel, there is enormous activity, although the makers find it difficult to get anything like the increased values they require to compensate them for the dearer production.

In military material all our local establishments are fully employed, working night and day, for the most part on British account. John Brown and Co., Limited, in addition to work for men-of-war, have received this week important orders for plates for fortifications. Vickers, Sons, and Maxim, Limited, have been required to provide guns and gun mountings for four battleships. The guns will be made at Sheffield, and the mountings at Barrow. At the latter establishment the gun-mounting department is so full of work that arrangements are being made to double the output.

The Sheffield Corporation are seeking powers to borrow £100,000 for the purpose of developing the electric light and power in the city.

NORTH OF ENGLAND.

(From our own Correspondent.)

WHILE the pig iron market has been quiet this week, owing to the operations of speculators in warrants, the manufactured iron and steel industries and all the trades allied thereto have shown more animation than ever, with further advances in prices. The "set back" in warrant prices was not due to any change for the worse in the condition or prospects of the pig iron trades, for any change there might be was rather the other way, but it was purely a speculative movement, due to some of the weak holders realising, and it was of very short duration, for Wednesday saw prices on the upward tack again, and speculators on that day were as eager to buy as they had on Monday and Tuesday been to sell, some of the leading firms of merchants buying freely. Not less than 71s. per ton has been quoted by makers this week for No. 3 Cleveland G.M.B. pig iron, and buyers have not been able to purchase at less, except in small quantities from second hands. The lowest figure that appears to have been taken was 70s. 6d., but since Tuesday the minimum has improved to 70s. 9d. Everything is favourable to advancing prices. The lower qualities of Cleveland pig iron have been altogether unaffected by the fluctuations in warrants, and are nearer in value to No. 3 than they have been for a long period. Thus 70s. is being paid for No. 4 foundry, 69s. 6d. for grey forge, and 69s. for mottled.

Business in hematite pig iron is almost at a standstill; not because buyers are holding off, but because makers cannot sell for early delivery, and will not sell for forward until they can estimate approximately what next year's prices of ore and coke are likely to be. Both these materials are increasing rapidly in value at present. Nominally the price of mixed numbers of East Coast hematite iron is 82s. per ton. To-day's price of Rubio ore is 20s. per ton delivered at the wharf, and it has been paid in a number of cases for early delivery; but merchants are reluctant to quote for next year's delivery, with the Spanish mine owners putting up prices so strongly against them. As a matter of fact, the Spanish mine owners know they have a good many merchants in a "tight place," as the latter have sold pretty freely to makers for next year, and have yet to cover their sales.

Shipments of pig iron from the Cleveland district this month are very fair, and what is rather a surprise is that so much iron is still sent to Scotland. For several months the difference between Cleveland and Scotch iron has been between 1s. and 2s. per ton, which would signify that Cleveland iron delivered to the Scotch founder will be 2s. 6d. to 3s. per ton dearer than Scotch iron, yet the deliveries continue heavy, and it is evident that the Scotch founders cannot well do without Cleveland iron in large quantities. The shipments from Cleveland to Scotland cannot now be held up by old contracts made when the difference of prices was greater. The quantity of pig iron shipped from the Cleveland district this month to 22nd has been 68,694 tons, as compared with 79,512 tons last month, and 62,803 tons in November, 1898. The stock of Cleveland pig iron in Connal's public warrant stores on Wednesday night was 80,036 tons, a decrease for the month of 4444 tons, of which 2399 tons was the record for Wednesday alone. The quantity held by Messrs. Connal is now the smallest that has been reported for several years. The stock of hematite iron was 11,153 tons, decrease for month 1800 tons.

The manufactured iron and steel industries are in an exceedingly strong and healthy condition, with the most encouraging prospects. The pressure of consumers to buy is quite unprecedented, and the advances do not check them in the least—on the contrary, it increases their anxiety to buy. Producers can afford to pick and choose their customers now, and have frequently to refuse orders, for the demand considerably exceeds the power of supply, not only in this district, but elsewhere. Prices in several branches have been further advanced this week, iron bars having gone up 5s.—making 10s. in a fortnight—and plates and angles, 2s. 6d. Thus £8 15s. must now be given for common iron bars, £9 5s. for best bars, £8 for iron and steel ship plates, £9 5s. for boiler plates, and £7 15s. for iron and steel ship angles. The sheet trade is very busy, and while steel black sheets are at £10 7s. 6d. for singles and £10 12s. 6d. for doubles, galvanised sheets are about £14 15s. Heavy steel rails are at £7 net at works. Sir Theodore Fry and Co.'s Spennymoor Rolling Mills, which were stopped for some weeks owing to the breakage of some of the machinery, have been re-opened.

The engineering industry continues very fully occupied, and there are no indications of an early termination of this condition of affairs. The same may be said of the bridge and wagon builders.

The demand for new steamers has received quite a stimulant this month, partly because of the war, and this though the advance in the prices of materials has necessitated the quotation of considerably enhanced prices by the builders. All the builders are so fully occupied that delivery of vessels now ordered cannot generally be given till well towards the close of next year.

The coal trade is active, and in all respects satisfactory—indeed, it is doubtful whether it was ever busier than at present, and yet the demands of consumers cannot be fully met. All branches alike are animated, and prices are being advanced. It is almost impossible just now to get plenty of steamers to take away the coal that has been bought for export. For best steam coal 13s. per ton f.o.b. is quoted, and has been paid, while the price for smaller varies from 7s. 6d. to 8s. Gas coal has risen to 14s. per ton f.o.b., and unscreened coking coals have been sold for next year's delivery at 13s., while that figure is also paid for unscreened bunkers. The demand from abroad for coke is very large, and it is quite impossible to meet it with the home requirements so heavy. Foundry coke has been sold at 27s. 6d. f.o.b., and blast furnace coke of medium quality fetches 22s. 9d. at the furnaces. The difficulty of getting full supplies is severely felt, and it is expected to be still more acute next month, on account of the holidays. The Northumberland Miners' Council have decided to follow the example of their brethren in Durham, in regard to the re-establishment of the Conciliation Board, which was dissolved at the end of 1896 after less than two years' existence, the Board being blamed for the wages reductions that took place during 1895 and 1896.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market was very strong towards the end of last week; but this week it has been rather unsteady. The advices received from the United States, though not indicating any material slackening in demand, were to the effect that manufacturers were not at present inclined to purchase more raw iron at the current high rates. A similar feeling exists in the West of Scotland; it has been altogether impossible, in some departments, to obtain prices for manufactured goods which would compensate for the very great advance in raw material. It is reported that while some holders of warrants were from such considerations inclined to realise, the "bears" also took advantage of the opportunity to make considerable sales. The market was thus depressed, especially on Tuesday, when Scotch warrants were done at 71s. 6d. cash, and 71s. 10½d. one month, being about 1s. 9d. below the best rates of last week. Cumberland and Cleveland warrants followed a somewhat similar course, the latter being done 1s. 8d. and the former 1s. 4d. below the best figures of last week.

Business has been done this week in Scotch warrants from 72s. 9d. to 71s. 6d. cash, and 73s. to 71s. 10½d. one month, the price subsequently improving to 72s. cash and 72s. 3d. one month. Cleveland warrants have sold from 70s. 9d. to 69s. 10d., and up to 69s. 11½d. cash, and at 71s. 2d. to 70s. 2d., and up to 70s. 3d. one month. The transactions in Cumberland hematite warrants have ranged from 79s. 11d. to 78s. 5½d., and up to 78s. 10½d. cash, and from 80s. 3d. to 78s. 11d., improving to 79s. 4½d. one month.

The demand on the part of consumers for Scotch pig iron is strong and well maintained, and the current output of the furnaces is not sufficient to meet it, and increasing inroads are accordingly being made on stocks. The stock in Connal and Co.'s Glasgow stores has been reduced during the past week 3930 tons.

The demand for hematite iron has been very good; indeed, it has been so pressing that makers have been enabled to further increase their prices. Merchants now quote 86s. per ton for delivery at the steel works.

Prices of Scotch makers' pig iron are again higher, and some brands are very scarce. Govan, f.o.b. at Glasgow, Nos. 1, is quoted 74s.; No. 3, 72s. 6d.; Wishaw and Carnbroe, Nos. 1, 78s.; Nos. 3, 76s.; Clyde, No. 1, 84s.; No. 3, 79s.; Summerlee, Gartsherrie, and Calder, Nos. 1, 85s.; Nos. 3, 80s.; Coltness, No. 1, 89s.; No. 3, 80s.; Glengarnock at Ardrossan, No. 1, 82s. 6d.; No. 3, 77s.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, Nos. 1, 80s.; Nos. 3, 78s.; Shotts at Leith, No. 1, 85s.; No. 3, 80s.; Carron at Grangemouth, No. 1, 86s. 6d.; No. 3, 70s. per ton.

The shipments of pig iron from Scottish ports in the past week have amounted to 5387 tons, compared with 4058 in the corresponding week of last year. To Canada 470 tons were despatched; India, 225; Australia, 18; France, 190; Italy, 455; Germany, 430; Holland, 240; Belgium, 125; Spain and Portugal, 125; China and Japan, 100; other countries, 490; the coastwise shipments being 2519 tons, compared with 774 in the corresponding week of last year.

The malleable iron trade is very firm, and business is reported to have been done without much difficulty at the advance of 10s. intimated last week. Ship angles and common bars are now quoted £8 15s.; best bars, £9 2s. 6d.; and best horseshoe iron, £9 5s. per ton, net delivered at Glasgow.

The steel trade is very firm, and it was reported on 'Change this week that inquiries are being made on behalf of the shipbuilders for a large amount of additional material. The Scotch steel makers have fixed their cash day for the 10th of each month, instead of the end of each month as formerly. It may be pointed out that this reduction of credit is practically equivalent to an advance in prices, and is indicative of the strength in the position of the steel trade. At the same time there can be little doubt that had it not been for the large amount of work in hand under contract, steel makers would have been asking higher prices on account of the great advance in pig iron.

Some of the engineering firms engaged in the manufacture of the sugar-crushing plant are very busy, having better orders in hand than at any former period in their experience. The locomotive engineers are also very busy, and so are the makers of other railway plant. The railway companies have been engaged producing trucks to carry very large loads, but it appears evident that the directors of the leading Scottish companies will be compelled to make further provision for their customers in the coal trade. Indignation is running very high at the unsatisfactory service which is presently afforded at many of the collieries.

The coal trade is stronger than ever; there has in the last few days been a remarkable development in the chartering of steamers in the Glasgow Exchange to carry coals to Mediterranean ports, and it is understood that between 30,000 and 40,000 tons of coals have been sold within eight or ten days for this trade. The demand for good steam coals has been very pressing. The extraordinary requirements of the Transport fleet had a very good effect on the steam-coal trade some weeks ago, and this is rather increased than otherwise. First-rate qualities of coal have been sold for delivery early next year up to 11s. 9d. and even 12s. per ton. The prices f.o.b. at Glasgow are as follows:—Main coal, 8s. 9d. to 10s.; steam, 10s. 9d. to 11s.; splint and ell, 11s. per ton. The best house coals are charged 18s. to 20s. per wagon of 24 cwt., for delivery to the consumer in Glasgow. There has been a marked improvement in the amount of coal shipments in the past week, the aggregate increase in the clearances over the preceding week at the Scottish ports amounting to nearly 30,000 tons.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

I HAVE to report a distinct advance of all coals throughout the district. That prices should touch 20s. for best steam last week was regarded as exceptionally high, but this week, when the members gathered on 'Change, Cardiff, on Monday, it was reported that for immediate delivery no less a sum had been paid than 25s. for 200 tons best steam, and holders of best seconds were firmly quoting 18s. to 19s.

Great quantities of coal continue to be despatched to coaling stations. Last week on one day over 12,000 tons were sent to Port Said from Cardiff, and on the same day, November 17th, six large cargoes to Cape Town. This was almost a record day as regards Cardiff, the number of coal-laden steamers despatched being twenty-six, and the total coal 63,970 tons. The Forest of Dean shares in the upward movement of coal. Last week the best house coal advanced 2s. per ton, and ordinary 6d. This week in the hill districts a further advance of 1s. 6d. was made in house coal.

Closing prices, Cardiff, mid-week, were as follows:—Best steam coal, 20s. to 21s.; second, 18s. 6d. to 19s. 6d.; drys, 16s. 9d. to 17s. 3d.; best Monmouthshire, 16s. to 17s.; seconds, 15s. 6d. to 16s. 6d.; best steam, smalls, 11s. 6d. to 12s.; seconds, 10s. 6d. to 11s.; best house, 16s. to 16s. 6d.; No. 3 Rhondda, 17s. 9d. to 18s.; brush, 14s. 6d.; small, 11s. 6d.; No. 2 Rhondda, 13s. to 13s. 6d.; through and through, 11s.; small, 8s. 6d. to 9s.

Swansea prices:—Anthracite, 15s. to 16s.; seconds, 13s. 6d. to 14s. 6d.; ordinary large, 11s. 6d. to 12s. 6d.; small rubbly culm, 5s. 9d. to 6s. 3d.: steam, 18s. to 20s.; seconds, 16s. to 17s.; bunkers, 11s. to 11s. 6d.; small, 9s. to 9s. 6d.; house, No. 3 Rhondda, through coal, No. 2 Rhondda, and small according to arrangement. Prices firm, with upward tendency.

Patent fuel, Cardiff, 16s. to 16s. 3d.; Swansea, 13s. 6d. to 14s. Coke, Swansea, furnace, 25s. to 26s.; foundry, 27s. 6d. to 30s.; Cardiff, furnace, 24s. to 25s.; foundry, 28s. to 30s.; special, 34s. to 35s. Pitwood is steadily going up, and is now quoted in Cardiff at 20s. to 20s. 6d.; Swansea, 20s. Lubricating oils advancing.

Three prominent men at one time in the industries of Wales died last week. Mr. Moxey, up to a late period chief manager of the great coal business of Messrs. Cory and Co., Cardiff; Mr. Benjamin Lewis, for a number of years a prominent man at the docks, Cardiff; and Mr. Bourne, a member of the old firm of E. Morewood and Co., tin-plate manufacturers, Llanelly.

Swansea coal shipments last week were still a little under late averages. Newport despatched over 80,000 tons foreign and coastwise. At Llanelly the coal trade is in full vigour, and the only complaint scarcity of men.

The iron ore shipments of the week into Newport, Mon., and Cardiff have been unusually large, and indicate well, not only existing needs, but probable requirements. Cargoes have come to hand from Malaga, Garucha, Castro, Urdiates, and Bilbao. The consignments were to Blaenavon, Ebbw Vale, Cyfarthfa, and Dowlais; the first named received 4500 tons on November 20th. Swansea last week received over 2000 tons. Pig iron has come in freely from Barrow, Workington, Millom, and Ulverstone to Swansea and Newport. Barrow cargoes were for the Cwmfelin Company, and some for Neath and Briton Ferry. The exports included rails to Waterford, and a fine consignment by the s.s. Clan Ferguson for Calcutta and Madras from Newport, Mon. This cargo was made up of 70 tons pig iron, 1000 tons steel sleepers, and 800 tons steel rails. Large inland despatches continue of tin-plate, bars, rails, and sheets.

There is no abatement in the activity of iron, steel, and tin-plate works. Rails and steel bars and plates are in strong demand. On 'Change, Swansea, mid-week, it was reported that pig iron had shown a reduction of from 4d. to 8d. per ton on the week, but that prices were fairly firm, and the fluctuations were regarded as due more to speculative than trade causes, and hence quotations remain generally. Merchant bars are in excellent demand, and prices show an advance in accordance with the Staffordshire market. Tin-bar prices are firm, and no business is being done under quotations. Block tin shows a slight but not a material reduction, nothing to benefit makers, who are making on the basis of late prices; demand strengthening, and prices very rigid.

Last quotations are:—Swansea: Glasgow pig iron warrants, 71s. 6d., 71s. 7d., 71s. 6½d., to 71s. 7d. cash buyers; Middlesbrough No. 3, 69s. 10d. and 69s. 8½d.; other numbers in proportion. Hematite warrants, 78s. 7d. and 78s. 5½d. for mixed numbers, according to brand. Welsh bars, £9 to £9 10s.; sheets, iron and steel, £9 15s. to £10; steel rails, heavy sections, £7 10s. to £7 15s.; light, £8 10s. to £9, f.o.t.; sleepers, &c., according to section and specification. Bessemer steel: Tin-plate bars, £6 10s.; Siemens, £6 12s. 6d. to £6 15s. Tin-plates: Bessemer steel cokes, 15s. 6d. to 15s. 9d.; Siemens, 15s. 9d. to 16s.; ternes, per double box, 28 by 20 C, 28s., 29s. to 33s.; best charcoal, 16s. to 17s. Big sheets for galvanising, 6ft. by 3ft. by 30 G, per ton f.o.t. £12 10s. to £13 10s.; finished black plate, £12 to £12 10s.; Canadas, £10 to £10 2s. 6d.; galvanised sheets, 21 G, £14 5s. to £14 10s. Block tin, £123 to £123 10s.; spelter, £20 15s.; lead, £17 17s. 6d. Copper: Chili bars, £74 12s. 6d. to £73 5s.

More tin mills are now working than have been the case for a long time. Last week the make was 57,776 boxes; shipments, 62 098 boxes; present stock, 141,301 boxes.

The Barry Railway Company have received the five locomotives from American builders; and now, I hear, have given large orders for others of a special type from Belgium. English builders, however, are not overlooked in the great addition they are making to rolling stock, for twenty-five have been ordered from leading firms in this country. This will total an increase of thirty locomotives, and hints at increased work at the docks, and the prospective business on the Rhymney line and the Vale of Glamorgan.

Swansea men have been exercised within the last few days in the correspondence between the Great Western Railway authorities and the Corporation, in the matter of the putting of Swansea on the main line. The secretary of the railway intimates that this will cost half a million of money, and in the likelihood of no material benefit resulting to the railway, he would be glad to learn the extent and manner of the contribution the Swansea authorities would be disposed to make in aid of the project. When read no official reply was forthcoming.

The sliding scale meeting of the South Wales Coalowners' Association was held this week in Cardiff, when a number of disputes were discussed and referred to arbitrators. At the close it was arranged that at the next meeting, on the 30th inst., the result of the audit for the two months should be published declaring the ruling wages for the ensuing months.

The joint Conciliation Board of the Welsh tin-plate conceded this week an advance of 15 per cent. on all sheets reckoned above the plate size. I understand that employers are quite prepared to meet in the same liberal way any special item which may come under notice.

NOTES FROM GERMANY.

(From our own Correspondent.)

DEMAND and employment are brisk and healthy as before, and consumption in iron and steel is very heavy in all branches. The iron ore trade in the Siegerland is in a fairly strong position, the mines having disposed of their output till end of next year; they have not shown the slightest inclination to bind themselves for 1901, but there is very little doubt that if contracts for that period should be accepted, buyers would have to give much more than they pay now. Present quotations for iron ore may, on the whole, be considered as rather too low when compared to the prices quoted for coke and for raw and manufactured iron. Crude iron continues in excellent demand. Supplies for next year's consumption are insufficient; some works have only secured about one-half of their demand in the third quarter, and for the first quarters of next year there is also but a comparatively small quantity of pig iron secured. Latest quotations were, for basic, M. 85 p.t.; foundry pig, No. 1, M. 95; No. 3, M. 90; good forge quality, M. 77 to M. 78 p.t. Billets, blooms, and ingots, are in brilliant request. Only about three-quarters of next year's demand in malleable iron have been covered; the billet convention is said to have asked their customers to purchase Siemens-Martin instead of basic, the former quality being less scarce. Convention price for raw bars in basic was M. 122 p.t. last week; billets, M. 127 p.t.; and plates, M. 131 p.t. Prospects are very fair in the manufactured iron trades. Current demand for bars is excellent, and a good number of forward orders have been booked. Prices show much firmness, M. 210 p.t. being offered for best sorts, while M. 185 to M. 190 p.t. is quoted for bars in mild steel. A large amount of work continues to be secured in the hoop trade; the mills are as briskly engaged as in summer, and have sold their output till July next year; especially the better sorts of hoops are vigorously called for. Girders and the various sorts of plates and sheets remain in brilliant request, and the output of the mills is as heavy as in early summer; sales in girders have lately been effected at M. 130 p.t. free Burbach, which is about M. 140 p.t. sold in the Rhenish-Westphalian district. Drawn wire is in very brisk demand for home consumption, and foreign inquiries are numerous, but a want of raw material prevents the mills from attending to foreign customers. For wire nails a good local demand is experienced, but exports are moderate and anything but satisfactory with regard to prices, American competition being keen, especially in East Asia. A most lively activity is reported to be going on at the tube mills; the rebate for galvanised pipes is 60 p.c., and for black pipes 47 p.c. In the railway and engineering departments much life is stirring, the shops and factories being, without exception, briskly occupied; prices are firm. There is talk of orders for 8000 to 8500 wagons holding out, so the shops need not fear a decrease in activity for some months.

On the Austro-Hungarian iron market the outlook just now is anything but bright. In some branches of business a slackening off in demand has already been perceived, and a tendency towards lower prices could be felt in many departments. A weak tone prevails in the building line, and very few orders only were given out upon the week. Fortunately a steady activity is still going on at the machine and wagon shops, and existing orders secure employment for some weeks ahead.

Home and foreign demand for iron and steel continue animated in Belgium, and the position of the market is altogether an exceptionally good one. The various iron-producing establishments are realising good profits now, and those who are inclined to take an optimistic view of things prophesy a further increase in demand and activity for the new year.

Employment at the French iron and steel works is very full and regular, and there are many and heavy orders pending, so the present position, as well as the outlook, in the iron business may be considered favourable. The condition of the railway and engineering trades continues to be particularly brisk; heavy steel rails fetch up to 250f. p.t.; light rails, 280f. p.t. For the Colonies and for the French districts in Africa, large contracts for railway rolling stock are holding out. Basis price for plates, No. 2, is 320f., and for steel plates 350f. p.t., Paris.

All the iron ore mines, as well as the blast furnaces and the steel works in Sweden have been, up to the present, in vigorous occupation, and are so well booked forward that an abatement of activity is not expected for the next two or three quarters. Export in iron, steel, and iron ore from Sweden during the first nine months of present year was larger than ever before; 220,859 t. iron and steel were exported, against 202,754 t. in 1898; iron ore, 1,364,907 t., against 1,165,173 t. Exports in iron ore from Morrland will increase now, the first 100 kilometres of the Ofoten Railway to the iron ore mines Kirunavaara having been finished on the 19th of October, and on the following day the first train with iron ore was sent from Kirunavaara to Lulia. Swedish home consumption in copper ore was so heavy that only 115 t. could be exported; in zinc ore 32,561 t. were sent to Belgium.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal: There is still a great pressure for all descriptions, and prices are advancing. House coal in fair request, and prices very firm. Steel and iron works are fully employed, and quotations for finished goods have an upward tendency. Tin and copper both slightly higher than last week's quotations. Exports for week ending November 18th were:—Coal: Foreign, 60,560 tons; coastwise, 20,968 tons. Sleepers, 1000 tons; rails, 800 tons. Imports for week ending November 21st were:—Iron ore, 26,454 tons; pig iron, 2640 tons; pitwood, 1422 loads; oak timber, 1657 tons; two cargoes cement.

Coal: Best steam, 17s. 6d. to 18s.; seconds, 16s. 6d.; house coal, best, 15s.; dock screenings, 10s. 6d.; colliery small, 10s.; smiths' coal, 10s. 6d. Pig iron: Scotch warrants, 71s. 9d.; hematite warrants, 78s. 9d. f.o.b., Cumberland; Middlesbrough, No. 3, 69s. 10d. prompt. Iron ore: Rubio, 18s. to 18s. 6d.; Tafna, 17s. to 17s. 6d. Steel: Rails—heavy sections—£7 10s. to £7 15s.; light do., £8 10s. to £9, f.o.b.; Bessemer steel tin-plate bars, £6 10s.; Siemens steel tin-plate bars, £6 15s. to £6 17s. 6d., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 15s. 6d. to 15s. 9d.; Siemens—coke finish—15s. 9d. to 16s. Pitwood: 18s. 6d. London Exchange Telegram: Copper, £75 10s. Straits tin, £129. Freights, firm.

CATALOGUES.

British Electric Transformer Manufacturing Company, Limited, Woodfield-road, London, W.—This is a neat little illustrated pamphlet, describing the construction and operation of the electric transformer.

Robert Boby, Limited, Bury St. Edmunds.—Illustrated catalogue of patent grain, malt, and seed-cleaning machinery.

Hudswell, Clarke, and Co., Leeds.—Illustrated price list of wrought-iron pulleys, shafting, hangers, couplings, wall boxes, angle brackets, &c. The pulley made by this firm is said to be alone in being wholly of wrought iron.

C. Whittaker and Co., Limited, Accrington.—Illustrated catalogue of brick and tile-making machinery This is a well-appointed book, being well printed, bound, and illustrated.

Estler Brothers, Leadenhall-street, London.—Catalogue of mirrors, lenses, ships' lanterns, lighthouses, &c.

Walter Newbold and Co., Gracechurch-street, London.—New revised catalogue of machine tools. The tools illustrated include lathes, planing machines, punching and steering machines, drills, and screwing machines.

The Unbreakable Pulley and Mill Gearing Company, Limited, West Gorton, Manchester.—Illustration of friction clutch countershafts made recently for a firm of Manchester engineers.

Polland and Co., St. Nicholas' Buildings Newcastle-on-Tyne.—Illustrated pamphlet describing the new "Beez" pocket volt and amperè meter. The makers claim that these instruments are useful in testing the electric igniting apparatus used in light oil motor vehicles.

TRADE AND BUSINESS ANNOUNCEMENTS.—The Gandy Belt Manufacturing Company, Limited, has removed from its Birmingham branch warehouse, 30, Temple-street, to more commodious premises at 4, Dale End (Albert-street), Birmingham.—At an extraordinary meeting of shareholders of Ruston, Proctor, and Co., Limited, held on the 16th inst. Mr. F. Howard Livens, A.M.I.C.E., chief engineer, who has been in the employ of the company for the past twenty-three years, was duly appointed a director of the company.

LOCOMOTIVES IN WAR.—Now that the capabilities of the locomotive in warfare are being eagerly watched by everyone, it is of particular interest to note that the Haigh Foundry Company built, in 1855, two eight-coupled engines for service in the Crimea. These were Nos. 109 and 110 in the firm's books; they had no regular fire-boxes, but inside circular furnaces 5ft. long, and ordinary tubes beyond. The cylinders were outside, 15 × 20, working the third axle. There were no flanges on the two middle pairs of wheels, all the wheels being as near together as they could possibly be. Two short stroke pumps fed the boiler, and there was also a hand pump which could be used to fill the boiler, or as a fire engine. A pressure of 120 lb. was employed. The duty of the engines was to run the guns out to the ends of a row of short sidings turning off a single line of way. If one got damaged the engine had to bring it in and take out a new one, up a gradient of 1 in 10. Of course the gun carriages had flanged wheels, the rails were mostly Barlow's saddle-backs, which had done duty on the Midland Railway. The cab was on the top of the boiler, and was made of iron plating. One of the engines got hit twice by the Russians, one shot smashing a cylinder and another carrying away the cab, and so injuring the driver's arm that it had to be amputated. He continued, however, to put guns in position with his one-cylinder engine, until at last Sebastopol gave in, but he died soon after. Neither of the engines was brought home, though one of them does not seem to have been hit. The Haigh Foundry only built four more locomotives, all in 1856, Nos. 111 and 112 being coupled in front, and the last two a six-wheeled Crampton, and No. 114, a bogie Crampton, with 6ft. 6in. four-coupled drivers, the cylinders working the trailing wheels. The business was taken over, when the lease expired, by Messrs. H. and F. H. Birley and R. Thompson, who practically dropped locomotive building, but carried on a colliery engineering business till 1884, since when the works have been closed.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 15th.

TELEGRAPHIC reports from half a dozen interior points up to this morning show that an extraordinary condition of things exists in the iron and steel market throughout the country. Inquiries since Monday morning have been large and urgent, not only for steel rails, but for all kinds of finished materials down to sheet iron and merchant steel. Most of these requirements come from small buyers, who have discovered that prices are still pointing upward and that their only safety lies in immediate protection. There are inquiries on the market for upward of 100,000 tons of steel rails and quotations are strong at 35 dols. to 37 dols. and advancing. Buyers of machinery are also in the market for considerable supplies, and find that during the past six weeks quotations have advanced from 3 dols. to 5 dols. a ton on certain lines of steel used. The consequence is that higher quotations are being made on all estimates for new work, but even these higher quotations have no effect upon prices or upon the determination of manufacturers to close contracts.

Never was there such an urgent demand for machinery of all kinds. A great many plants are re-equipping, or throwing out old machinery and putting in new. Repairs are very extensive, and the supplies of broken-up machinery are unusually large. There is nothing particularly new in the pig iron market, excepting that the scarcity is more marked than two or three months ago. The production of 290,000 tons per week does not satisfy requirements. All railroad companies are endeavouring to place orders for cars, and some extremely large orders have been placed within the past two or three weeks. In consequence of placing of these orders, bar iron makers are crowded with inquiries for supplies.

An advance has taken place in common iron to 2.25 dols. at Pittsburgh, and 2.35 dols. East. Refined iron is 2.50 dols. at Pittsburgh and higher here. Some mills are making concessions on merchant steel for next spring delivery. Buyers of merchant pipe expect more favourable quotations after the opening of the new year, when mills will be partially caught up. This is the dull season for sheet iron, but prices have not been shaded materially. Skelp iron is dull, but mills are all loaded with business. Lake ore rates suddenly dropped 1.50 dols. per ton. The conditions which confront the American iron trade for the coming year are higher priced ore, higher transportation, higher priced labour in some lines, and higher prices for all equipment necessary. In addition to this there is the constant danger of a stringency in the money market, but we will face these dangers when we meet them.

LAUNCHES AND TRIAL TRIPS.

JOHN BARRY, steel cargo steamer; built by, Joseph L. Thompson and Sons, Limited; to the order of, John H. Barry and Co., of Whitby; dimensions, 320ft., 47ft. 5in., 24ft. 9in. moulded; engines, triple-expansion, 23in., 38in., 62in., by 42in. stroke, pressure 160 lb.; constructed by, John Dickinson and Sons, Limited; launch, November 7th.

BARENDSZ, steam trawler; built by, Cochrane, Cooper, and Co., Limited, of Selby; to the order of, Van Vliet and Co., of Ymuiden, Holland; dimensions, 115ft. 4in. by 21ft. 6in., and 11ft. 6in. moulded; engines, triple-expansion, 13in. by 21in., and 34in. by 24in. stroke, pressure 180 lb.; constructed by, Sir Christopher Furness, Westgarth, and Co., Limited; trial trial, October 6th, 10½ knots.

DRACHENFELS, steel screw steamer; built by Wigham Richardson and Co., Limited; to the order of, the Deutsche Dampfschifffahrts Gesellschaft Hansa, of Bremen; to carry, 10,000 tons deadweight; engines, quadruple-expansion, pressure 210 lb.; constructed by, the builders; launch, November 16th.

HARRIET, steel screw steamer; built by, Wm. Gray and Co., Limited; to the order of, Martin Carl, of Copenhagen; dimensions, 250ft., 35ft. 6in., 18ft. 2in.; engines, triple-expansion, 18in., 28½in., 47½in., by 33in. stroke; constructed by, the builders; trial trip, November 15th; 10½ knots.

STROMBUS, oil-carrying and general cargo steamer; built by, Sir W. G. Armstrong, Whitworth, and Co.; to the order of M. Samuel and Co., of London; dimensions, 410ft., 52ft., 33ft. 9in. moulded; to carry, 8450 tons deadweight; engines, triple-expansion, 28in., 46in., 77in., by 45in. stroke, pressure 180 lb.; constructed by, the North-Eastern Marine Engineering Company; will burn liquid fuel in the boilers; launch, November 18th.

EVA, side ballast tank steamer; built by, Wm. Gray and Co.; to the order of, Mr. M. Jebsen, of Hamburg; dimensions, 350ft., 51ft., 27ft.; to carry, 6200 tons; engines, triple-expansion, 25½in., 40½in., 67in., by 45in. stroke, pressure, 170 lb.; constructed by, the builders; launch, November 18th.

FREIBURG, steel screw steamer; built by, Furness, Withy, and Co., Limited; to the order of, Norddeutscher Lloyd, of Bremen; dimensions, over 400ft. long, measurement capacity, 12,900; engines, triple-expansion, 28in., 44in., 75in., by 48in., pressure 180 lb.; constructed by, Sir Christopher Furness, Westgarth, and Co.; launch, November 17th.

EDUARD BARY, steel screw steamer; built by, Ropner and Son; to the order of, Furness, Withy, and Co., Limited; dimensions, 325ft., 48ft., 24ft. 3in.; to carry, 5200 tons deadweight; engines, triple-expansion, 1100-horse power, pressure 160 lb.; constructed by, Blair and Co., Limited; launch, November 17th.

MANCHESTER SHIPPER, cattle and cargo steamer; built by, Irvine's Shipbuilding and Dry Docks Company; to the order of, the Manchester Liners, Limited; dimensions, 382ft., 48ft., 36½ft.; to carry, 10,666 tons, and 500 head of cattle; engines, triple-expansion, 25in., 41in., 69in., by 48in. stroke, pressure 180 lb.; constructed by, William Allan and Co., Limited; launch, November 18th.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

8th November, 1899.

22,297. TRANSMISSION DYNAMOMETERS, T. Foster, Manchester.
22,298 ELECTRIC RAILWAYS or TRAMWAYS, T. Scott, London.
22,299. ATTACHMENT CLIPS, A. Hoskins, Birmingham.
22,300. LUBRICATING SHAFTS, S. Hunter and G. Milne, Newcastle-on-Tyne.
22,301. BASKET and COT, J. H. Brookes-Smith, Manchester.
22,302. VARIABLE-SPEED GEAR, E. J. West and The Progress Cycle Company, Limited, Coventry.
22,303. GUIDING ELECTRICAL TROLLEYS, I. Dixon, Liverpool.
22,304. TACKLE for DISCHARGING CARGOES, P. Hassall, Liverpool.
22,305. VALVES for PNEUMATIC TIRES, A. P. Loscher, Manchester.
22,306. ELECTRIC ARC LAMPS, C. C. Ridings, Birmingham.
22,307. METAL POLISH, E. Harrison, Bradford.
22,308. TELEPHONE SWITCHBOARD CABLE, A. Whalley, Warrington.
22,309. RIB DEVICE for UMBRELLAS, E. H. Brown, Manchester.
22,310. OIL LAMPS, J. Watts, Birmingham.
22,311. PIPES for TRANSMITTING HEAT, A. W. Cooper and J. S. Greig, Dundee.
22,312. TROUSERS CREASER, T. Owen, Aberystwyth.
22,313. GOVERNOR for ENGINES, R. Wilby, Batley, Yorks.
22,314. TURNING over LEAVES of MUSIC, H. W. Jones, London.
22,315. PENHOLDERS, J. Glass, London.
22,316. TICKET CASES, J. Glass, London.
22,317. ELECTRIC ARC LAMPS, C. Curwen, London.
22,318. FIRE GRATES, F. A. Hickson, Kingston-on-Thames.
22,319. PLOUGHS, D. Worthington and C. Petersen, Kingston-on-Thames.
22,320. DRIVING MECHANISM, The Cambridge Scientific Instrument Company, Limited, and M. J. Wayne, London.
22,321. CARTRIDGE CARRIERS, W. Lindsey.—(*T. C. Orndorff, United States.*)
22,322. SASH FASTENERS, F. H. Martin, Birmingham.
22,323. COMBINATION STUD and TIE HOLDER, J. A. Crane, Birmingham.
22,324. SELF-ACTING MULES and TWINERS, M. Musgrave, J. Walsh, and T. Kitchen, London.
22,325. LAMPS, G. Whyte, London.
22,326. HOT-AIR ENGINE, A. G. Melhuish, London.
22,327. LAMP, E. Alinot, London.
22,328. POINT PROTECTORS for HAT-PINS, E. S. Priest, London.
22,329. HAND BRAKE for RAILWAY WAGONS, V. I. Feeny, London.
22,330. ROLLER BEARINGS. M. C. P and C. V. Thierry, G. D. Sturrock, and F. F. H. L. Mennons, London.
22,331. ROLLER BEARINGS. M. C. P. and C. V. Thierry, G. D. Sturrock, and F. F. H. L. Mennons, London.
22,332. CUTTING OUT BISCUIT, H. A. E. Dürkoop, London.
22,333. TELEPHONE EXCHANGE SYSTEMS, P. H. Cole, London.
22,334. ENGINES, G. M. Demoulin, London.
22,335. MACHINE for CALENDERING FABRIC, J. Gebauer, London.
22,336. PACKAGE CARRIERS for CYCLES, C. W. Smith, London.
22,337. MANUFACTURE of LAMP-BLACK, G. Wegelin, London.
22,338. ELECTRICAL SWITCHES, Evered and Co, Ltd, and S. Evered, London.
22,339. VAGINAL SYRINGES, L. O. Crosswell, London.
22,340. PIANOFORTE CASES, C. R. S. J. Hallé, London.
22,341 PRODUCING STOCK MATERIAL from BILLETS, C. S. Morse, London.
22,342. FREE WHEEL for CYCLES, The Hub Two-Speed Gear Company, Limited, and W. H. Palmer, Manchester.
22,343. TROUSER PRESS, A. Anderson and G. Adie, London.
22,344. FLUID PRESSURE ENGINES, J. Kirby, London.
22,345. PRODUCTION of COLOURS, A. E. and E. Peyrusson, London.
22,346. PHOTOGRAPHIC CAMERAS, F. A. Fichtner, London.
22,347. PAPER-CUTTING MACHINE, R. K., H, G., and A. Fomm, London.
22,348 CIGARETTE-PAPER ROLLS, M. Wangemann, London.
22,349. BRAKES for CYCLES, H. Wissner, London.
22,350. COLOUR PRINTING, J. Wetter.—(*The Firm of Meisenbach, Riffarth, and Co., Germany.*)
22,351. KNEADING or MIXING MACHINES, R. Trenck, London.
22,352. PNEUMATIC HAMMERS, H. J. Kinman, London.
22,353. TOPOGRAPHICAL INSTRUMENTS, P. O. Aubry, London.
22,354. BOOKS for the USE of the BLIND, S. A. K. Strahan, London.
22,355. CARS for ADVERTISEMENT PURPOSES, H. F. Wagner, London.
22,356. APPARATUS for FILLING BOTTLES, W. Hanemann, London.
22,357. SUCTION APPARATUS, W. Hanemann, London.
22,358. FOLDING PHOTOGRAPHIC CAMERAS, C. P. Goerz, London.

9th November, 1899.

22,359. BURNERS for INCANDESCENT LIGHT, M. Sheftel, London.
22,360. PANORAMIC LOCKET, J. Krieg, Baden, Germany.
22,361. CHARGING LIQUID with GAS, G. Friess, Baden, Germany.
22,362. PREPAYMENT GAS METERS, W. O. Green, Brentford.
22,363. CYCLE BRAKES, G. Gilbert and E. Mushing, Coventry.
22,364. MACHINES for WINDING TAPE, R. Abell, Derby.
22,365. TAPPING DEVICES for BARRELS, A. Howat, Manchester.
22,366. RECEPTACLE for FEEDING ANIMALS, E. A. Bellow, Leominster.
22,367. PRESSES for CLICKING PURPOSES, J. A. Keay, Leicester.
22,368. BOX-COVERING MACHINES, N. B. Chadwick, Stockport.
22,369. OIL ENGINES, E. Lisle and G. Prew, Wolverhampton.
22,370. PROCESS for COVERING ROLLERS, E. Rolffs, Manchester.
22,371. WASHING PHOTOGRAPHIC FILMS, H. Coventry, Liverpool.
22,372. CANS, J. A. Sutcliffe, Manchester.
22,373. PRESSURE GAUGES, &c., J. J. Guest, Birmingham.
22,374. BURNERS for LIQUID FUEL, R. C. Ayton, Coventry.
22,375 COUPLING for RAILWAY WAGONS, W. McKenzie, Glasgow.
22,376. STEERING LOCK for CYCLES, T. W. Gorton, Birmingham.
22,377. COIN-FREED CYCLE RACKS, J. M. Lockerbie, Birmingham.
22,378. AUTOMATIC SIGNALLING and BRAKE APPARATUS, E. Hendschel, Liverpool.
22,379. CYCLE BRAKE MECHANISM, H. Beeston, London.
22,380. DOUBLE-STOREY PASSENGER CARRIAGES, L. J. Todd, London.
22,381. SAFETY DEVICE for WATER GAUGES, O. Decker, London.
22,382. PREVENTING ACCIDENTS to PERSONS CLEANING WINDOWS, E. P. Viehweger, London.
22,383. DRIVING GEAR of VELOCIPEDES, W. E. Partridge, Birmingham.
22,384. CHEMICAL ELECTRICAL EXCITANTS, J. Post, London.
22,385. MILK URNS, N. Musiar, London.
22,386. APRONS for OUTSIDE SEATS, A. A. Tyler, W. March, and H. Penn, London.
22,387. GUARD for IRONING MACHINES, W. E Baker, London.
22,388. JEWELLER'S RING TRAYS, A. J. Baker and W. H. Ellam, Sydenham.
22,389. PRODUCING ACETYLENE LIGHT, T. H. Lewis, London.
22,390. BELT APPLIANCE, R. R. Neyle, London.
22,391. PRODUCTION of IMITATION FABRICS, E. Heusch, London.
22,392. CARBONATING LIQUIDS, C. B. V. Horn, London.
22,393. COMPOSITION for COATING CEILINGS, A. C. Ratel, London.
22,394. PREVENTING MOISTURE ACCUMULATING on GLASS, L. Trickey, London.
22,395. PHONOGRAPHS, N. Caro, London.
22,396. BALL-HEADED SCREWS, H. Folley and F. R. Baker, Birmingham.
22,397. BRAKES, E. T. Cleathero, London.
22,398. CORRUGATED TUBES, C. D. Abel.—(*Dampfkessel und Maschinenbau Actien Gesellschaft W. Pitzner and K. Gamper, Russia.*)
22,399. AUTOMATIC LIQUID FUEL STORAGE, A. H. Swinton, London.
22,400 PAPER FASTENERS, G. Hayes, London.
22,401. SHOCKLESS VALVES, J. H. Dales, Elstree, Herts.
22,402. TIME INDICATOR for CHESS, R. Beveridge, London.
22,403. PRODUCTION of AMMONIA, R. Pearson, London.
22,404. CONVERTIBLE BELTS, L. N. Dyhrberg and G. K. Askin, London.
22,405. BERDY'S INTERCEPTOR, J. M. Berdy, London.
22,406. BRAKES for BICYCLES, W. Billing, Birmingham.
22,407. CHECK VALVES, W. J. Wood and S. W. Simpson, London.
22,408. TREE for BOOTS, H. H. Lake.—(*O. A. Miller, United States.*)
22,409. BOOTS, E. Parent, London.
22,410. MECHANISM for DRAWING TEA, T. Hyatt, London.
22,411. GEAR WHEELS for MOTORS, C. Manners, London.
22,412. TIRES for WHEELS of VEHICLES, C. Manners, London.
22,413. PREVENTING DOWN-DRAUGHT in FLUES, A. O. Neville and J. Carpenter, London.
22,414. PRESSES for TROUSERS, F. Hoare, London.
22,415. BRUSHES, W. Sterkel, London.
22,416 WATER-TUBE BOILERS, J. E. Thornycroft, London.
22,417. GOLF PRACTICE APPLIANCES, J. McHardy and Anderson, Anderson, and Anderson, Limited, London.
22,418. PILE FABRICS, H. Reyss and F. Bredtmann, London.
22,419. RAILWAY SIGNALLING DEVICES, W. P. Thompson.—(*L. and E. Lepszy, Austria.*)
22,420. WOVEN DRIVING BELTS, W. P. Thompson.—(*The Mech, Triebriemen-Weberei u. Seilfabrik Gustav Kunz A.G, Germany.*)
22,421. CARBURETTORS, L. Lhotel and F. Plancher, London.
22,422. VESSEL for EXPLOSIVE LIQUIDS, G. Ulrich, London.
22,423. PRODUCING TYPEWRITTEN MATTER, A. Halstrick, London.
22,424. PROTECTING BOOTS from WEAR, R. G. Fraser and G. Jeanes, Liverpool
22,425. MANUFACTURE of ACETYLENE, G. J. Atkins, Liverpool.
22,426. GAS ENGINES, A. E. Shiner and C. W. Higgs, London.

10th November, 1899.

22,427. VALVES for PNEUMATIC TIRES, C. K. Welch, London.
22,428. JEWELLERS' BLOW PIPE, G. R. Carpenter, Wanstead.
22,429. WAGONS for SCAVENGING PURPOSES, R. Wadsworth, Halifax.
22,430. ADJUSTABLE BED-TABLE, J. H. Pike, Norwich.
22,431. FRICTION HOISTS, E. O. Puddephatt, Leeds.
22,432. LIFE-COLOURED PRESSED WOOD PANELS, D. Rylands, Cheshire.
22,433. FEEDING PAPER to PRINTING MACHINES, W. Bridgewater, Leicester.
22,434. THE COAL DROSS UTILISER, P. Orphoot, Berwick, N.B.
22,435. PROPELLERS for VESSELS, W. Smith, Paisley.
22,436. APPLYING BRAKES to VELOCIPEDES, A. I. B. Maxfield, Birmingham.
22,437. CASTORS, Cope and Timmins, Limited, and J. G. Rollason, Birmingham.
22,438. EVAPORATING, &c., APPLIANCES, W. M. Millar, Glasgow.
22,439. JOINTS for CORNICE POLES, W. A. Bibb, Birmingham.
22,440. WAR GAME, W. H. Allen, Bristol.
22,441. MACHINERY for MAKING BOXES, W. L. Jackson, Glasgow.
22,442. RAILWAY CHAIRS, A. D. Cock, Bristol.
22,443. MATERIAL for PRESERVING EGGS, J. F. Cragoe, Bristol.
22,444. CASTING, J. and J. Wiggin, Bloxwich, Staffs.
22,445. FASTENINGS of BALE HOOPS, F. Wilson, Manchester.
22,446. RIM BRAKES for VELOCIPEDES, J. Harrington and J. A. Ryley, Coventry.
22,447. KNIFE, FORK, and SPOON CLEANER, O. Eastwood, Elland, Yorks.
22,448. DRAWING and SLIVER-DIRECTING APPARATUS, W. Thompson and A. W. Glover, Halifax.
22,449. COOLING APPARATUS for DAIRIES, L. Marx, Glasgow.
22,450. SCREW-CUTTING DIES, W. R. Anderson, Glasgow.
22,451. DELIVERING WATER, W. Engelke and F. Meyer, Glasgow.
22,452. RAFTS for SAVING LIVES, M. Peschmann, Potsdam, Germany.
22,453. STOPPING WATER BOTTLES, D. Cuff, Manchester.
22,454. PACKING RINGS, W. R. Renshaw, Stoke-on-Trent.
22,455. HORSESHOE, J. F. Edds and D. N. Wade, London.
22,456. APPLIANCE for COOKING PURPOSES, E. Jürgens, Berlin.
22,457. CIGARETTE HOLDERS, M. Schmiedeknecht, Berlin.
22,458. MACHINE for THRASHING PURPOSES, A. von Loeper, Dundee.
22,459. HOPPER WINDOW, C. C. and M. H. Mallett, Southend-on-Sea.
22,460. SAFETY CARVING FORKS, E. E. Jackson, London.
22,461. APRONS, F. C. Blake, London
22,462. GRAVE FITTINGS, H. Schmid, London.
22,463. PUZZLE, G. A. Knapp, London.
22,464. GAME, C. J. S. Makin, London.
22,465. ROLLER BEARINGS for CYCLES, P. A. Ransom, London.
22,466. MANUFACTURE of COKE, E. F. Andrews, London.
22,467. MOULDINGS for PICTURE FRAMES, E. E. Cohen, London.
22,468. ARMOUR PLATES, T. G. Challis and W. J. Hunter, London.
22,469. HATPINS for LADIES, K. F. and J. Powell, London.
22,470. CHAIRS, J. and R. J. Foot, London.
22,471. CHIMNEY-SWEEPING APPARATUS, W. Angus, London.
22,472. GEAR WHEELS, H. H. Lake.—(*F. O. Bullis, United States.*)
22,473. GEAR WHEELS, H. H. Lake.—(*F. O. Bullis, United States.*)
22,474. REGULATING DRAUGHT in FURNACES, R. Bensal, London.
22,475. DOOR and other LATCHES, J. and J. S. Bell, London.
22,476. BASINS, A. Hutchison, London.
22,477. DOOR-OPENING DEVICE, L. W. B. Stöcker, London.
22,478. DEVICE for CUTTING CARDBOARD, W. H. Marsh, London.
22,479. REVOLVERS, G. C. Dymond.—(*H. F. Landstad, Norway.*)
22,480. BUFFERS, J. F. Spong, London.
22,481. WIND MUSICAL INSTRUMENTS, H. Starck, London.
22,482. SPRING CLIP for SUSPENDING UMBRELLAS, &c., E. S van Rooyen and J. S. Lewy, London.
22,483. REFRIGERATOR, A. D. W. King and J. H. Howell, London.
22,484. FERMENTING BEER, A. D. W. King and J. H. Howell, London.
22,485. AUTOMATIC FIRE SPRINKLERS, L. A. Weston, London.
22,486. ANTI-FRICTION AXLE BEARINGS, F. H. Heath, London.
22,487. LAMPS, J. McHardy and R. A. Snelgrove, London.
22,488 MOTORS for PROPELLING CARS, A. P. Dodge, London.
22,489. PNEUMATIC CYCLE SADDLES, W. H. Holden, London.
22,490. HAT FASTENER, J. C. Ramsbottom, London.
22,491. SYPHONS for EXTRACTING LIQUIDS, E. H. Whiting, London.
22,492. AXLE-BOXES for RAILWAY WAGONS, R. F. Thompson, London.
22,493. CLUTCHES for OPERATING PROPELLERS, C. E. Dawson, London.
22,494. COUPLINGS for HOSE PIPES, L. de L. Wells, London.
22,495. COLLARS, C. A. Wilson, London.
22,496. PRISM PLATES, The British Luxfer Prism Syndicate, Limited, London.
22,497. CONDENSED BLOOD FIBRENE MANURE, R. Marrison, Norwich.
22,498. CHAIRS, G. A. Dallas, London.

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22,499. BRAKES for VELOCIPEDES, J. I. Cooper, Sheffield.
22,500. TIRE and RIM BRAKE for BICYCLES, J. B. Pegden, Hull.
22,501. LIGHTING SEWING MACHINES, H. Powers, Earby, near Skipton, Yorks.
22,502. SYRINGES, G Baird, London.
22,503. LUGGAGE CARRIER, J. L. Herbert, Llandrindod, Radnorshire.
22,504. RECEPTACLES for HOLDING PENS, G. S. Colvin, Glasgow.
22,505. BRUSHES for SIEVES, C. J. Robinson, Liverpool.
22,506. CONSTRUCTING BAMBOO COTS, J. O. Brooke, Leeds.
22,507. STARTING ENGINES, R. Jackson and A. Firth, Liverpool.
22,508. FRICTION CLUTCH, R. Jackson and A. Firth, Liverpool.
22,509. ENEMAS and MEDICAL SYRINGES, A. H. Lessees, Liverpool.
22,510. FLAT CARDING ENGINES, W. and A. Draper Bolton.
22,511. CONCRETE for ROOFING PURPOSES, G. E. Clare, Chelmsford.
22,512. SELF-SUPPORTING KNICKERBOCKERS, W. Ford, London.
22,513. DEVICE for GENERATING STEAM, D. Macdonald, Glasgow.
22,514. DEVICE for LOCKING NUTS, F. A. Murphy, Manchester.
22,515. RUNNING GEAR for VELOCIPEDES, W. Fairweather.—(*Safety Three Wheel Vehicle Company, United States.*)
22,516. ACETYLENE GAS GENERATORS, A. Stern, London.
22,517. ELECTRIC INFLUENCE MACHINE, W. R. Pidgeon, London.
22,518. GRINDING TOOLS, C. H. and F. J. Dale, London.
22,519. ORE-CRUSHING MACHINES, W. H. Baxter, London.
22,520. CYCLE SADDLES, G. C. Bond and F. Sadler, London.
22,251. IGNITERS, A. H. C. Gibson and W. Wright, London.
22,522. REGISTERS for MANUSCRIPT MUSIC, L. Gillrath, London.
22,523. CYCLE WHEELS, A. Nicklin and G. Maude, London.
22,524. ATMOSPHERIC BURNER FITTING, J. W. Collis, London.
22,525. CLEANING INCANDESCENT ELECTRIC LAMPS, H. J. Haddan.—(*R. E. Simms, United States.*)
22,526. STEAM GENERATORS, W. P. Thompson.—(*G. Reibaldi and C. Mazza, Italy.*)
22,527. CARBURETTING AIR, W. P. Thompson.—(*The Firm of Gebrüder Buxbaum, Germany.*)
22,528. DESIGNS for ORNAMENTING CEILINGS, T. A. Ashworth, Liverpool.
22,529. FLYERS for CORDAGE MANUFACTURE, C. S. McConnan, Liverpool.
22,530. FIRE-PROOFING of BUILDINGS, J. Bassett, Birmingham.
22,531. TRANSPORTING AMBULANCE STRETCHERS, E. G. Payne, London.
22,532. CANDLE DRAUGHT GUARD, F. B. Hanbury, London.
22,533. SYSTEMS of ELECTRICAL DISTRIBUTION, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
22,534. GENERATING ELECTRIC CURRENTS, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
22,535. ROTARY ELECTRIC CONVERTERS, The British Thomson-Houston Company, Limited.—(*W. B. Jones, United States.*)
22,536. ELECTRIC CIRCUIT CHANGERS, The British Thomson-Houston Company, Limited.—(*E. Ortez, United States.*)
22,537. SPOOL-SUPPORTING BRACELETS, A. Denekas, Washington, U.S.A.
22,538. BOILERS, W. Schmidt and H. Elsner, London.
22,539. AUTOMATIC DELIVERY APPARATUS, J. M. Lester, London.
22,540. FELLING and CUTTING TIMBER, A. Ransome, London.
22,541. ACETYLENE LAMPS, W. Dederich.—(*O. Scharlach, Germany.*)
22,542. MACHINE for WRITING in CIPHER, G. W. Dudley, London.
22,543. ARTIFICIAL TEETH, C. Reininghaus, London.
22,544. COLLECTORS for ELECTRIC RAILWAYS, O. Kirstein, London.
22,545. TINS for PRESERVED FOODSTUFFS, H. Pollman and A. Link, London.
22,546. DRYING WOOD, N. Caro, London.
22,547. ROSIN SIZE, F. Arledter and G. Huth, London.
22,548. CHART DRAWING INSTRUMENTS, E. N. Moyer, London.
22,549. CEMENT, J. C. Gostling, J. H. Fraser, and R. Booth, London.
22,550 SUPERHEATER for LOCOMOTIVE STEAM BOILERS, F. von Grubinski, London.
22,551. POSTAL CARDS, A. J. Boult.—(*E. G. Resch, Germany.*)

,552. Electric Glow Lamps, F. W. Schroeder, A. Couch, and P. W. Moran, London.
2,553. Pillars Composed of Several Parts, J. B. Granjon, London.
22,554. Obtaining Carbon, L. Gaster, London.
22,555. Phonographic Apparatus, A. Grelet and L. Vives, London.
22,556. Electric Bell Pushes, W. G. Hicks, London.
22,557. Incubators, J. Mann, London.
22,558. Preparation of Yeast, W. Smithson, London.
22,559. Temperature Regulators, J. Mann, London.
22,560. Retaining Covers of Railway Wagons, G. Armstrong, London.
22,561. Manufacture of Cigars, H. H. Leigh.—(*P. Baetcke, Germany.*)
22,562. Clamps for Suspending Bicycles, F. J. Cox, London.
22,563. Filter Presses, J. B. Alliott, London.
22,564. Manufacture of Tea Chests, J. C. Roberts, London.
22,565. Waterproof Coverings for Walls, R. A. Sayer, London.
22,566. Adding and Subtracting Machine, G. and R. Schwarz, London.
22,567. Manufacture of Soot, R. Thalwitzer, London.
22,568. Equilibrium Slide Valves, W. Schmolka, London.
22,569. Automatically Turning on, &c., Gas Flames, J. O. Spong, London.
22,570. Driving Reins, C. A. Rose and W. F. Gardiner, London.

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22,571. Domestic Fire-grates, E. R. A. Matthews, Birmingham.
22,572. Expanding Holes in Tubes, F. Schilling and J. Schurz, Halifax.
22,573. Dyeing Hanks of Yarn, J. Rhodes, jun., Bradford.
22,574. Tool Holder for Planing Machines, J. Barrow, Glasgow.
22,575. Weaving Textile Fabrics, W. Garlick, Manchester.
22,576. Manufacturing Carbonate of Magnesia, W. and J. Marsh, Manchester.
22,577. Friction Clutches, A. E. Sayer, Birmingham.
22,578. Self-propelled Vehicles, H. Wilcke, Liverpool.
22,579. Coupling Railway Wagons, T. W. Howson, Manchester.
22,580. Brake-controlling Mechanism for Cycles, J. Holt, Birmingham.
22,581. Contact Makers for Electric Cars, T. H. Parker, Wolverhampton.
22,582. Race Game Devices, W. C. Haigh, Manchester.
22,583. Spinning and Bleaching Yarns, J. H. Lees-Milne, Manchester.
22,584. Cleaning Pipes, W. Driver and J. Ramsay, Newcastle-on-Tyne.
22,585. Ploughs, T. Moss, Manchester.
22,586. Protecting Boots and Shoes, E. A. Jeffreys, Birmingham.
22,587. Additions to Boots and Shoes, E. A. Jeffreys, Birmingham.
22,588. Delivery Mechanism, W. D. Starkey and J. Wilkinson, Birmingham.
22,589. Cycle Brakes, R. Bamber, Liverpool.
22,590. Ship Lights, J. Shaw and J. Grantham, Willington-on-Tyne.
22,591. Kneading Machines, C. Fleck, Barmen, Germany.
22,592. Belt Fasteners, H. Weihtag, Barmen, Germany.
22,593. Machine for Pressing Earthenware, J. P. Guy, London.
22 594. Coupling Drive, S. Nelson, Newcastle-on-Tyne.
22,595. Knicker Buckle, T. J. Wilson, Dublin.
22,596. Back-pedalling Brake, C. H. J. Harding, London.
22,597. Locking Device for Lamps, G. W. Goldring, London.
22,598. Golf Practice Apparatus, J. G. Warren, London.
22,599. Gun Mountings, A. Reichwald.—(*The Firm of F. Krupp, Germany.*)
22,600. Buffers, J. F. Spong, London.
22,601. Winches, J. C. Hoch, J. F. and H. Tietgen, London.
22,602. Potato Diggers, D. Buchanan, London.
22,603. Trawl Boards for Fishing, G. D. Irwin, London.
22,604. Device for use of Swimmers, K. F. Höglund, London.
22,605. Valve Water-closets, H. L. Doulton, London.
22,606. Valves for Water Heaters, H. L. Doulton, London.
22,607. Feed-water Regulator, F. M. Chappell, London.
22,608. Clasp Hooks, C. F. C. Edholm, London.
22,609. Electric Lighting of Vehicles, E. R. Hill, London.
22,610. Rope Grip, W. B. Brown, T. H. Webb, and E. H. Young, Liverpool.
22,611. Cans, C. J. Lee, Liverpool.
22,612. Graphophones, G. L. Hogan, Liverpool.
22,613. Photographically Recording Rays of Light, A. Pollak, J. Virág, G. Egger, and F. Silberstein, Liverpool.
22,614. Photographic Developing Apparatus, A. Pollak, J. Virág, G. Egger, and F. Silberstein, Liverpool.
22,615. Safety Device for Electric Switches, A. J. Atterberg, Liverpool.
22,616. Spanner, W. Förster, London.
22,617. Thief-proof Letter-box, J. W. Simmonds, London.
22,618. Lathe Tools, H. S. Land, London.
22,619. Winning Gold from Ores, J. Diether and M. Merz, London.
22,620. Automatic Double Coupling, H. Robinson, London.
22,621. Looking-glass Movements, G. Moore, jun., Birmingham.
22,622. Exhibiting Pictures, P. W. Davies and H. H. Shanks, London.
22,623. Taps, G. O. H. Klopp, London.
22,624. Appliance for Automatically Releasing Falling Horses from the Poles of Vehicles, F. McQueen, London.
22,625. Lighting Torches, G. F. L. Foulger and J. G. Glover, London.
22,626. Breakwaters, A. G. Evans.—(*J. W. W. Hopkins, Argentine Republic.*)
22,627. Coin-freed Game Apparatus, R. E. Wickes, London.
22,628. Manufacturing Metal Pipes, A. Schmitz, London.
22,629. Pneumatic Sheet-feeding Device, F. P. Baur, London.
22,630. Producing Linen-like Ware, A. Langer, London.
22,631. Plumbers' Shave Hook, W. J. Waylan London.
22,632. Slipper Soles, J. D. Cooper and M. Hale, London.
22,633. Producing Acid, R. B. Ransford.—(*L. Casella and Co., Germany.*)
22,634. Engines, C. H. Taylor, London.
22,635. Fittings for Hinged Tables, R. J. Campbell, London.
22,636. Oil Engines, C. E. Dawson, London.
22,637. Spanner, W. T. Hatton and C. G. Guernsey, London.
22,638. Filters, A. G. Sheak, London.
22,639. Preparations of Quinine, J. Y. Johnson.—(*Vereinigte Chininfabriken Zimmer and Co., Germany.*)
22,640. Materials for the Manufacture of Colouring Matters, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
22,641. Operating Window Sashes, G. Barnes, London.
22,642. Apparatus for Marking Wrappers, W. Rose, London.
22,643. Typewriting Machines, J. C. Fell.—(*Wyckoff, Seamans, and Benedict, United States.*)
22,644. Typewriting Machines, J. C. Fell.—(*The Union Typewriter Company, United States*)
22,645. Machine for Destruction of Weeds, C. Panten, London.
22,646. Automatic Coupling, J. A. Robinson, London.
22,647. Window Opener, A. H. Fisher, Melbourne, Victoria.

14th November, 1899.

22,648. Gentlemen's Shirts, R. H. S. Hall, London.
22,649. Bicycles, A. Cooper, London.
22,650. Breaking Electric Circuits, L. W. Heath, Newtonsmith, Galway.
22,651. Staircases, J. A. Willmore, London.
22,652. Manufacture of Wire Sections, S. Cowper-Coles, London.
22,653. Vehicle Tires, A. Dugdale and E. Harding, Manchester.
22,654. A Toy, T. F. Fagg, Folkestone.
22,655. Self-acting Hoists, J. S. and C. E. V. Hall, Newark-on-Trent
22,656. Ambulance Stretcher, J. Wakeley, Walthamstow, Essex
22,657. Free Wheels for Cycles, T. Crook, Preston.
22,658. Motor-driven Vehicles, R. M. Moore, Romiley, Cheshire.
22,659. Hat Box, B. Churchill, London.
22,660. Mechanical Toys, H. L. Cox, London.
22,661. Corset Attachment, R. L. Young, Glasgow.
22,662. Troughs for Electric Cables, A. E. Tanner, Manchester.
22,663. Saddle for Bicycles, J. A. Sharrock, Driffield, E. Yorkshire.
22,664. A New Game, A. Gourley, junior, Glasgow.
22,665. Bicycle Support, D. Macdonald, Glasgow.
22,666. Chemical Generator of Electricity, E. L. Anderson, Manchester.
22,667. Hair Fasteners, J. Kreuter, Manchester.
22,668. Cased Tubing, C. Harvey, Birmingham.
22,669. Dyeing Yarns, W. H. Eastwood, Manchester.
22,670. Padding for Wearing Apparel, J. Wyatt, London.
22,671. Seat Action Closets, M. J. Adams, Leeds.
22,672. Retaining Shirt Sleeves, M. Austin, Manchester.
22,673. Advertising Kite, R. H. Battersby, Southport, Lancs.
22,674. Toy, H. W. Wilson, East Dereham, Norfolk.
22 675. Wire Seating for Tramcars, S. C. Nutter, Halifax.
22,676. Photographic Cameras, D. H. Houston, Glasgow.
22,677. Game, T. Bickford, Glasgow.
22,678. Nut-locks, F. G. Stark, Glasgow.
22,679. Electro-magnetic Appliance, J. L. Cutler, Glasgow.
22,680. Elevator Device, U. S. Alz and H. S. Nagengast, London.
22,681. Spinning Fibrous Substances, J. Harrison, Manchester.
22,682. Corset, A. A. Roscoe, London.
22,683. Ships' Propellers, P. M. Staunton, Howth, Co. Dublin.
22,684. Tobacco-plant Paper and Pulp, G. E. Skiros, London.
22,685. Tubes, A. Pilkington, London.
22,686. Mattresses, A. Weiss, London.
22,687. Driving Gear of Cycles, &c., J. Honey, London.
22,688. Crank for Cycles, E. T. W. Fairweather, London.
22,689. Galvanising Apparatus, G. Harrison.—(*The New Process Coating Company, United States*)
22,690. Boots, J. A. Kelly and S. E. Bowman, London.
22,691. Incandescent Gas Burners, H. A. Kerr, London.
22,692. Motion-reversing Mechanism, R. Ewing, London.
22,693. Measuring Instruments, &c., F. Ullmer, London.
22,694. New Coin-freed Game, G. C. Whadcoat, London.
22,695. Wheels for Velocipedes, A. E. Hobson, London.
22,696. Pillar Letter Boxes, F. Childerstone, London.
22,697. Pencil Holder for Golf Players, E. E. Digby, London.
22,698. System of Registering Statistics, L. R. March, London.
22,699. Steering Gear, A. J. Boult.—(*R. W. Jamieson, United States.*)
22,700 Oil-feed for Explosion Engines, A. Craig, London.
22,701. Disintegrating Animal Matter, J. Chase, London.
22,702. Electricity Meters, A. J. Boult.—(*O. Patin, France.*)
22,703. Printing Machines, H. E. Newton.—(*R. Hoe, United States.*)
22,704. Mail Box Time Indicator, V. I. Feony.—(*The Montague Indicator and Letter Box Company, United States.*)
22,705. Destruction of Sewer Gas, J. E. Webb, London.
22,706. Treating Distillers' Wash, C. Sudre and C. V. Thierry, London.
22,707. Distribution of Electricity, A. Sweet, London.
22,708. Block Signalling for Railways, G. H. Jelfs, London.
22,709. Cooking Stoves, W. Youlton, London.
22,710. Electrolytic Extraction of Zinc, H. H. Lake.—(*S. Stepanov, Russia.*)
22 711. Rubber Tires, H. H. Lake.—(*F. Richardson, United States.*)
22,712. Manufacture of Explosives, C. E. Bichel, London.
22,713. Friction Couplings, E. Seger, London.
22,714. Plaster, C. Straub, London.
22,715. Bleaching of Sugar Juices, I. Kitsée, London.
22,716. Heel-breasting Machines, H. H. Lake.—(*McKay Shoe Machinery Company, United States*)
22,717. Bread Seals, C. Raymond.—(*O. Goublin, France.*)
22,718. Coin-receiving Appliances of Coin-freed Machines, T. Fryer, London.
22,719. Street Sweepers, A. Brown, London.
22,720. Generation of Acetylene Gas, H. Simmons, London.
22,721. Cabinets, J. R. Burton, London.
22,722. Gas Stoves, L. Kessel, London.
22,723. Combined Locks and Lift-up Latches, A Cashin, Birmingham.
22,724. Acetylene Gas and Burner, A. Westrop, Enfield.
22,725. Signals for Cars, H. S. Jones.—(*Litzelmann and Tailfer France.*)
22,726. Bottling Small Quantities of Vendible Liquids, T. Eves, London.
22,727. Combined Bottle Stopper and Sprinkler, W. W. Lowrey, London.
22,728. Construction of Grates and Ovens, R. Blackwell, Manchester.
22,729. Valves for Pulsating Steam Pumps, J. B. Foxwell, Manchester.
22,730. Drawing Compasses, J. W. Setten, Birmingham.
22,731. Locks and Latches, H. H. Leigh.—(*H. Mollenhauer and W. Mayer, Germany.*)
22,732. Water-tight Doors, H. H. Leigh.—(*F. J. Sprague, F. T. Bowles, and G. H. Hill, United States.*)
22,733. Hair Combs, W. H. Whiting, London.
22,734. Trap for Rats, F. Horsfall, London.
22,735. Wheels for Velocipedes, G. H. Rayner.—(*W. Williams, Cape Colony.*)
22,736. Suspending Garments upon Doors, W. J. Butcher, London.
22,737. Dumb Bells, O. Stanley, London.
22,738. Bicycle Wheels, H. Elliott and J. Carpenter, London.
22,739. Protecting Cuffs from being Soiled, F. M. d'Auvergne, London.
22,740. Cycle Cranks, S. J. Leonard, London.
22,741. Giving Orders to Waiters, L. H. Greene, London.
22,742. Petroleum Lamps, M. Graetz, London.
22,743. Flushing Apparatus for Water-closets, A. Thieulin, London.
22,744. Piston Packing, A. Goodwin, London.
22,745. Loading Coal in Ships' Holds, J. Gibson, London.
22,746. Printing Machines, G. L. Hoyt, London.
22,747. Producing Light, W. H. Smith and W. Willis, London.
22,748. Screw Jacks, M. H. Thofehrn, London.
22,749. Machine for Making Casks, O. Poland, London.
22,750. Slow Combustion Stoves, &c., R. Knoth, London.
22,751. Dividing Dough, D. W. A. Haagen and F. K. A. W. Rinau, London.
22,752. Iron Folding Bedsteads, J. Montgomery, London.
22,753. Barrel-making Machinery, J. S. Oram, London.
22,754. Alternating Arc Lamps, W. J. Davy, London.

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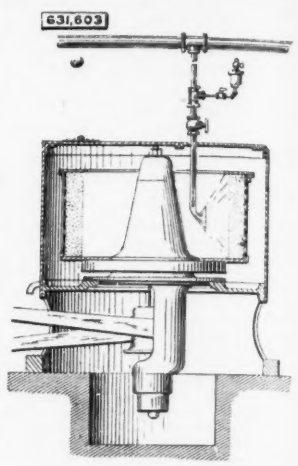
22,755. Automatic Supply Machines, W. L. Dennis, London.
22,756. Boxes, C. Weidinger and F. Kiesewetter, Halifax.
22,757. Engines, W. H. Willson and M. S. Conly, Kingston-on-Thames.
22,758. Vehicle Wheels, J. J. Folks, Kingston-on-Thames.
22,759. Manufacturing Artificial Stone, J. T. Szék, London.
22,760. Lock for Railway Wagons, G. W. Bebbington, Chester.
22,761. Cycle Gear, C. H. M. Wharton and T. Postings, Manchester.
22,762. Electrical Switchboards, E. W. Cowan, Manchester.
22 763. Flying Machine, or Airship, J. Jones, Dundee.
22,764. Motor Car, H. Cave, Coventry.
22,765. Pencil Holder and Protector, R. H. Mateer, Belfast.
22,766. Feed-water Heaters for Boilers, G. Green, Keighley.
22,767. Heel Plates, D. W. Fessey and L. Timmins, Birmingham.
22,768. Lock Mechanism, J. G. Punhome, Willenhall, Staffs.
22,769. Fastening Ladies' Hats, L. Michael, Cardiff.
22,770. Hand Brakes for Vehicles, W. S. Laycock, Sheffield.
22,771. Mules, R. Taylor, Manchester.
22,772. Fabrics for Covering Meat, B. Kershaw, Manchester.
22,773. Taper Extinguishers, F. D. Blackbee, Boscombe, Hants.
22,774. Exercising Apparatus, J. H. Harrison, Manchester.
22,775. Forming Spade Sockets, J. and P. Hodkinson, Manchester.
22,776. Weaving Stair Carpets, E. Craig, London.
22,777. Thread-spooling Machines, J. Booth, Glasgow.
22,778. Boxes, A. R. Buckton, Hull.
22,779. Machines for Cutting Potatoes, S. Whiteley, Leeds.
22,780. Balances, S. W. Suffield, Birmingham.
22,781. Means for Opening Envelopes, R. Sinclair, Edinburgh.
22,782. Game, H. W. Wilson, East Dereham, Norfolk
22,783. Saddle, F. Smith, Galway.
22,784. Telephones, D. Macdonald, Kilmarnock.
22,785. Tinted Film Covering for Lamps, F. Round, Southport.
22,786. Coat Suspenders, R. Procter, Burnley.
22,787. Drying Organic Substances, A. Totte, Manchester.
22,788. Acetylene Gas Lamps, S. Richter, Halifax.
22,789. Explosive Figure for Amusements, J. Mason, London.
22,790. Invalid Chairs, A. C. Roberts and F. S. Smith, London.
22,791. Ornamental Tablet, R. W. Barker.—(*F. A. Jumeau, France.*)
22,792. Extinguishing Lamps, A. E. Wright, London.
22,793. Marine Life-saving Jacket, W. Clarke, London.
22,794. Bread, C. Junge.—(*J. Weiss, Switzerland, and A. Strauss-Collin, Germany*)
22,795. Carbonic Acid Gas Engines, G. S. Dobrashian, London.
22,796. Manufacturing Metal-cased Tubes, T. H. Lawton, London.
22,797. Spring Wheel Tire, L. Taffurelli, London.
22,798. Non-alcoholic Beer, O. G. C. L. J. Overbeck, London.
22,799. Preparation for Protecting Carboys, F. Archamboult, London.
22,800. Curtain Bracket for Bedsteads, W. Barnsley, Birmingham.
22,801. Corsets, S. Landridge, Birmingham.
22,802. Punching Registers, C. Berst, Kingston-on-Thames.
22,803. Driving Mechanism for Cycles, K. S. Murray, London.
22,804. Dinaphthylamine Derivatives, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
22,805. Holding Edges of Trousers in Position, E. A. Hörlin, London.
22,806. Furnaces, H. H. Lake.—(*F. A. Dalay, United States*)
22,807. Manufacturing Lead Peroxide, H. Beckmann, London.
22,808. Bicycle, G. Edrico, London.
22,809. Magnet Cores for Transformers, O. T. Blathy, London.
22,810. Stentering Machines, A. A. Whitley, London.
22,811. Fabric, M. Y. and H. N. Barlow, London.
22,812. Appliance for Transfer of Objects, G. Kirby, London.
22,813. Microphones, J. Egger and A. Pollak, Liverpool.
22,814. Seats, A. E. Follows and D. J. G. Miller, Liverpool.
22,815. Lamp Chimneys, J. Bate, Liverpool.
22,816. Automatic Cycle Pumps, W. Loubinger, Liverpool.
22,817. Ovens, E. Schroeder, Manchester.
22,818. Manufacturing White Lead, J. A. de la Fontaine, Manchester.
22,819. Candle-making Machines, A. Findlater, Manchester.
22,820. Flushing Apparatus, C. Nuber, London.
22,821. Drag Devices for Bobbins, &c., S. Smith, London.
22,822. Boxes for Merchandise, &c., H. Masters, London.
22,823. Cord-manufacture Apparatus, A. Melson and Co., Limited, A. Melson, and G. E. Lyons, London.
22,824. Moulding Machinery for Metal Castings, The Moulding Syndicate, Limited, and H. Tabor, London.
22,825. Producing Blocks of Coal, M. Waissbein, London.
22,826. Knitting Frames, W. Spiers and T. S. Grieve, London.
22,827. Registering Apparatus, A. J.-B. E. Dartas, London.
22,828. Gas-generating Apparatus, W. Ross, London.
22,829. Insulating Composition for Electric Battery Cases, Phelps's Metal, Limited.—(*C. J. Hubbell, United States.*)
22,830. Batteries, S. Robinson.—(*S. R. V. Robinson, United States*)
22,831. Coin-freed Automatic Machines, J. C. Russell, London.
22,832. Generation of Ozone, C. A. Sahlström, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

631,603. Process of Refining Sugar, *M. Zahn, Arten, Germany.—Filed March 23rd*, 1896.

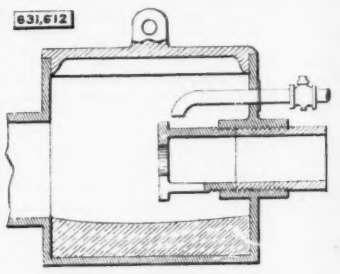
Claim.—The process of refining sugar, which consists in forcing through the same superheated steam at a temperature of 180 deg. Cent., and a pressure of six-tenths of a kilogramme per square centimetre or there-



about, to free the sugar crystals from adhering syrup and at the same time heat them to a point where no heat will be required for drying the sugar, and as the refining is nearing completion forcing a mixture of colouring matter and syrup into and through the mass of sugar crystals, substantially as described.

631,612. Apparatus for Effecting Combustion of Liquid Fuel for Furnaces or the Like, *J. & V. Bickford, Camborne, England.—Filed May 8th*, 1899.

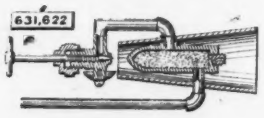
Claim.—An apparatus for the combustion of liquid fuel, consisting of a chamber having a refractory bed and an opening at one side, an air supply pipe projecting into the chamber at the opposite side, and constructed at its inner end portion with a longi-



tudinal slit in its under side, a contracted orifice and a slit leading from said contracted orifice to said longitudinal slit, and a liquid-fuel supply pipe terminating in a bend which delivers the liquid fuel upon the inner end portion of said air supply pipe, substantially as described.

631,622. Burner, *E. C. Dickerson, San Antonio, Tex.—Filed December 21st*, 1898.

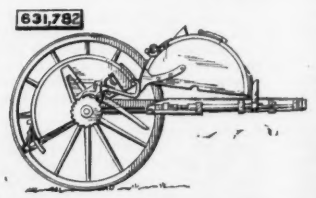
Claim.—A burner consisting of a vaporiser, comprising a hollow body having one of its ends conically shaped, the interior of the vaporiser being adapted for generating vapour, a conical jacket or deflector, the smaller portion whereof is of greater diameter than the diameter of the vaporiser, said vaporiser being



contained within the said jacket or deflector, the conical end of the vaporiser being at the contracted end of the jacket or deflector, a reservoir adapted to contain liquid fuel, a fuel-supply pipe connected with reservoir and with the chamber of the vaporiser, and a vapour-conducting pipe connected also with the chamber of the vaporiser, and a needle-valve carried by the vapour-conducting pipe, said valve facing the pointed end of the vaporiser, substantially as described.

631,782. Apparatus for Mixing Concrete, Mortar, &c., *I. H. Fisher, Washington, D.C.—Filed May 15th*, 1899.

Claim.—An apparatus for mixing concrete, mortar, and similar materials, comprising a drum composed of two sections hinged together, and



arranged to be opened to dump, means for rotating said drum when closed, and mechanism for releasing the drum from the rotating means when the hinged sections are opened, substantially as described.

ENGLISH AND AMERICAN RAILWAYS.

No. I.

IN THE ENGINEER of September 15th we discussed certain comparisons between English and American railways, in the course of which we criticised somewhat severely the claims made that English railway traffic is conducted less efficiently than American traffic. We stated that if the methods of working were really so economical as we are told they are, there should be a dividend, whereas hardly more than 33 per cent. of the stock of American railways pays any dividend. There is, of course, another side to this question, namely, the American side, and this has been presented to us by a correspondent who is familiar with both English and American railways. We give his views in the following article.

In the first place, while the cost of American railways has averaged but about one-fourth the cost of English railways, the cost of maintenance is very high if we include in such cost the general improvements in the line which are made necessary by the growing traffic. The reduction of gradients and curves, the construction of heavy steel bridges to replace less permanent structures, the filling in of timber trestles with solid embankments, double-tracking, new sidings and yards, handsome modern stations, heavier rails and permanent way construction, all form serious items of expense. Of course, most of this work is on the western and southern lines, but it suffices to affect the average figures, and even the trunk lines find it necessary to make large expenditures in general improvements, especially in stations, terminals, and yards, and in permanent way appliances, all this being made necessary by the increasing traffic, the heavier locomotives and cars, and the greater train loads. Many railways have also been compelled to make enormous expenditures for raising or lowering their lines in cities in order to eliminate level crossings. It may be said that the railways ought to have been built more substantially, in order to be free from these expenses for improvements. But at the times when most of these lines were built it would not have been wise policy, even if it had been possible—and, in general, it would have been impossible—to raise the necessary funds, to incur such a great initial expenditure. What was wanted was a railway of the most economical construction, and built in the shortest possible time. This was provided, lines with heavy gradients and temporary bridges being rapidly built, while in many cases no one could have foreseen the future of the traffic and the operating conditions.

Not all railways were so cheaply built, and at this day the United States has railways which are in no way inferior to the best European and English trunk lines in matters of construction.

Another very important point is, that while the first cost was less, the earnings are also very much less on the average. The railways of the United States aggregate about 186,000 miles in length, with a cost of about £11,000 per mile, and gross earnings of £1300 per mile. In Great Britain there are about 22,000 miles of railway, which have cost about £45,000 per mile and earn about £4000 per mile. This relation of the earning capacity of English and American railways is very generally overlooked, but it has a very powerful influence upon statistics which have reference to dividends and financial returns. Again, while 66 per cent. of the stock pays no interest, only 12 per cent. of the bonds pay no interest, and many individual American railways form as good investments as English railways. Many others will be equally good in time, but time must be allowed for the development of traffic and earnings to a point comparable with those of English railways. American railways were very largely built to open up new country and develop traffic, while English railways have mainly been built to accommodate existing traffic in densely-populated districts. It is but fair to consider these factors in making a simple comparison of dividends.

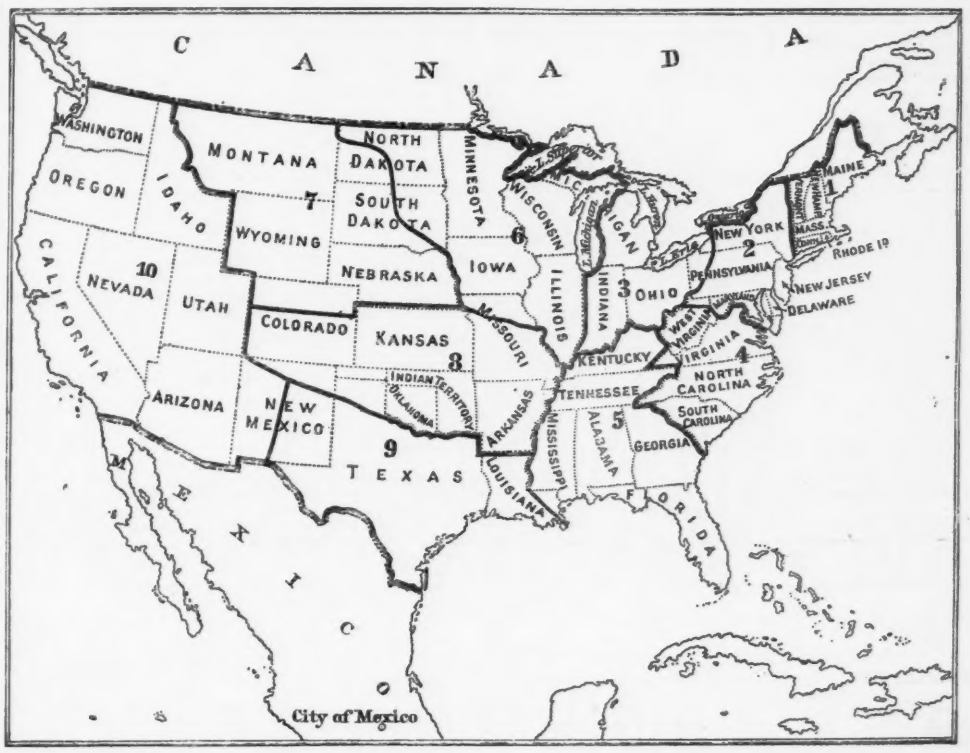
As to free grants of land, while many of the western lines received land grants, such grants are rare on the busy lines in districts comparable to England in point of traffic, population, and commerce. In fact, such lines often have to incur heavy expenditures for additional land in towns and cities for widenings, yards, terminals, &c.

On the other hand, the taxes imposed by the municipalities, counties, and the various States, are in many cases very onerous. They amount on many railways to from 2 to 3 per cent. of the capital, 2 to 4 per cent. of the gross earnings, and even 12 per cent. of the net revenue is sometimes consumed in their payment. On the New York Central Railroad, during the year ending June 30th, 1899, the taxes were £407,672, equal to 2 per cent. on the entire capital of the company, or £170 per mile of road worked. These taxes required for their payment 12 per cent. of the year's net earnings. On the Chicago and North-Western Railway, the taxes, including war revenue taxes, were £234,135, or £46 per mile, this road being in a very different section of the country. On the Erie Railroad, the taxes amounted to £407,672, or £77 per mile of road worked. It must be remembered that the Legislature of each State has jurisdiction over all railways within that State, except in regard to Interstate traffic, so that railways of any importance are usually subject to restrictions, taxes, and unfriendly interference from several State Governments. Considering what railways have done to develop the country, and what a necessary feature they are for the further development and welfare of the country, it is rather strange that the people and the various legislatures should be actively unfriendly to the railways. Be the reason what it may, however, the fact remains that at the present time there is a decided and widespread feeling of enmity, particularly among the local legislators, and various pretexts are sought for harassing and bleeding the companies by laws and taxes.

It is pointed out, also, that it is not well to make a general comparison between the 186,000 miles of American railways—which include prairie and development lines whose traffic is yet comparatively small—and the 22,000 miles of English railways. In preparing the Government statistics of railways, the Interstate Commerce Commission from the first recognised that broad averages concerning 186,000 miles of railway of all kinds, and operated under the most varying conditions, could give no really useful information. It therefore divided the country into ten sections or groups of States, in each of which the conditions were approximately similar, and this division is shown on the accompanying map. In all the Government statistics, therefore, the totals and averages for each group are given, as well as those for the country as a whole.

Taking the report for 1898, we find that while an average of 66·26 per cent. of the stock of all American railways paid no dividend, the percentage in the several groups varied from 20·98 to 88·79 per cent., these being for the extreme eastern and extreme western groups respectively. Similarly, while an average of 11·34 per cent. of the total bonds paid no interest, in different groups the non-paying percentage ranged from 5·72 to 39·56 per cent. The working expenses averaged 65·58 per cent. of the gross receipts for the whole United States, but averaged 53·82 to 71·63 in the different groups. The distance travelled per passenger averaged 26·70 miles for the whole United States, but averaged 17·55 to 80·20 miles in the groups. The goods journey is even more varied, the grand average being 129·78 miles per ton, while the group averages were from 81·88 miles to 233·66 miles per ton.

From the Interstate Commerce Commission's report for 1898, the tables on p. 536 have been compiled, showing the financial and operating conditions of railways in the ten groups and in the United States as a whole. Table No. 1 gives statistics of mileage, capital, and rates.



Tables No. 2 and No. 3 show the percentages of stock and bonds paying varying rates of interest. The stock amounts to £1,077,653,664, of which £363,622,616 paid an average dividend of 5·29 per cent.

The low financial returns of American railways are due largely to the continual shrinkage in goods rates, which in many cases far exceed the growth in traffic. The railways, therefore, have to handle an ever-increasing traffic at ever-decreasing rates, and under such conditions it becomes necessary to introduce all possible economies in operation. It would not do simply to reduce expenses wholesale—such a policy would mean that the line and its equipment would in a very short time be in such a condition that it could not handle traffic economically at all, and large expenditures would then be necessary. The American railways have sought and made their economies in another direction. They have recognised that the present conditions are permanent, and that no increase in rates is to be looked for. Consequently it is in the work of transportation or handling the traffic that economies should be made, so as to keep the cost of handling the traffic always below the charge that can be made for this work. In order to effect this the lines have been put in first-class condition, gradients and curves are improved, new sidings or double-track built, and the permanent way strengthened. All this greatly facilitates the train service, and powerful engines and cars of great capacity are introduced, so as to obtain the full benefit of the economies due to the hauling of the heaviest possible train loads, and the lowest possible relations between dead-load and live-load. With such trains, the increased traffic may be handled with very little increase in train or engine mileage, and with consequently little increase in wages or running expenses.

Having already given the averages of traffic and financial conditions for the several groups of American railways, it may be instructive and interesting to consider the conditions prevailing on individual lines. The New York Central Railroad owns 819 miles of line, but owns and controls 2895 miles. The stock £20,000,000, and bonds £58,800,000, aggregate £78,800,000, of which £57,042,500 are issued and outstanding. The amount of capital stock per mile of road owned—819½ miles—is £24,406. Upon this great investment it pays 4 per cent. interest on the stock and 3½ to 7 per cent. on the bonds, but to do this, in spite of the steady reduction in freight rates or goods rates, requires careful and wise management, and the exercise of every possible means to reduce the operating expenses in their relation to earnings. From the company's report for the year ending June 30th, 1899, it appears that the freight traffic was 1,953,000 tons greater than in the previous year, showing an increase of 8½ per cent. But the freight earnings, however, increased by only £6600, or less than one-eighth of one per cent. The reason for this is that the average rate per ton—2000 lb.—per mile decreased from 0·305d. in 1898 to 0·295d. in 1899. In other words, the rate was about one farthing for carrying 2240 lb. one mile.

The total cost of operation was reduced by £76,400, while the cost of conducting transportation was reduced by £89,631. The increase in traffic was handled with but a slight increase in engine mileage, while the train mileage was actually reduced. The introduction of twenty-eight new goods engines, each capable of hauling eighty grain cars of 30 tons capacity, resulted in a saving of 505,114 train miles, or a decrease of 3½ per cent. from 1898, in spite of the 8½ per cent. increase in volume and traffic. Each of these grain trains represents a gross load of 3600 tons. More engines of this class are being introduced, and further economies will thus be effected by the use of more powerful engines and heavier train loads. The average train load, on through goods service, was 750 tons, but it must be explained that west-bound trains—from New York—have a large proportion of empty cars, the loaded traffic being mainly in the direction of the shipping port.

The lowest freight rate thus far reached, and to which the average of many railways is steadily falling, is less than one farthing per mile per ton of 2000 lb. This was reached by the Chesapeake and Ohio Railway during the year ending June 30th, 1899. The average rate on coal carried to the coast was 0·11d. per ton per mile, while on goods other than coal it was 0·219d. This was not any revolutionary change, but a step in a steady downward course of freight rates since 1892. This road carried an average paying load per goods train of 425 tons—46 tons more than in 1898—but the actual load with coal trains is very much higher. This road, however, is peculiar in that a large part of its goods traffic consists of coal hauled direct from the docks to the shipping wharves on the seaboard, and there is a small proportion of local trains and of high-class goods. With a sufficiently great amount of this low-class through goods traffic, and with the heaviest practicable train loads, such traffic may be very profitable. Another road, carrying iron ore in trains of 2137 tons—exclusive of engine and tender—from ports on the great lakes to the steel works of Pittsburgh, had an average rate of 0·21d. per ton per mile in 1898.

On the Lake Shore and Michigan Southern Railroad last year, the goods rate was 0·251d., as against 0·272d. in 1897. This reduction more than counterbalanced an increase of 31 tons in the average train load, so that the earnings per train mile were a fraction less than in 1897. On the other hand, it is to be noted that the railway carried 1,500,000 tons more goods traffic than in 1897, so that there was a gross increase in freight receipts in spite of the decrease in rates. Had 1898 been a less favourable year, however, or had the increase in train load—with its consequent economy—not been effected, it is easy to see that the financial conditions might have

been very serious. Of the 0·251d. received per ton per mile, 0·165d. was absorbed by cost of transportation, leaving 0·086d. for profit. The receipts were, passenger per mile averaged 1·047d., of which 0·740d. went to pay for cost of transportation, leaving 0·307d. for profit. The dividend earned in 1898 was 8·13 per cent., and a dividend of 7 per cent. was paid.

On the Erie Railroad, the fractional reduction of 0·037d. in the average freight rates resulted in a net shrinkage in revenue of £396,451, which strikingly illustrates the serious effects of infinitesimal rate reductions in the aggregate. As stated in the annual report, it is still a hard struggle to meet the fierce competition in rates and service coming from all directions. The goods traffic is being hauled at an average cost of 0·179d. per ton per mile. While there is undoubtedly a possibility of further reducing the cost of doing the business, there is a limit to this reduction; but there are no signs of any limit to the continual reduction in the rates charged for doing the business. The average rate on coal was 0·218d., while on general goods traffic, including both coal and merchandise, it was 0·258d. The average cost of carrying one ton of goods one mile was 0·198d., a decrease of 0·75 per cent. from 1898. Excluding taxes, which are hardly a part of the cost of transportation, the cost was but 0·179d. The report states that the unsatisfactory feature is the continual decrease in the rate received.

TABLE No. I.

	Miles of railway.	Miles per 100 sq. miles.	Miles per 10 000 inhabitants.	Capital in stock and bonds.	Per cent. of working expenses to gross receipts.	Receipts per passenger per mile.	Receipts per ton per mile.	Journey per passenger.	Haul or lead per ton.	Gross earnings per mile (from working).	Working expenses per mile.	Net income per mile.
				£		d.	d.	miles.	miles.	£	£	£
New England States	7,472	12·05	13·71	89,830,289	69·71	0·913	0·588	17·55	81·88	2271	1582	367
North Atlantic States... ...	21,011	19·38	13·17	448,868,973	65·35	0·893	0·308	19·88	112·74	2921	1909	376
Middle States	23,095	18·33	23·73	290,366,133	71·18	0·972	0·289	35·44	119·89	1488	1059	107
South Atlantic States... ...	11,581	8·32	20·20	104,502,267	65·95	1·111	0·296	38·98	215·26	883	582	81
Eastern Gulf States ...	21,891	7·30	20·85	178,306,047	67·59	1·104	0·417	42·64	116·70	938	627	67
Middle Western States ...	41,317	11·10	34·72	389,444,416	62·17	1·026	0·413	31·67	144·76	1180	734	174
North-Western States ...	10,626	2·57	63·94	102,099,643	54·82	1·219	0·578	80·20	167·48	900	484	186
South-Western States... ...	23,038	6·31	40·40	253,032,755	65·58	1·109	0·480	51·56	175·25	980	642	94
Western Gulf States	11,307	3·49	32·77	100,076,286	71·63	1·174	0·521	52·52	173·23	883	632	—
Pacific Slope States	15,058	1·98	55·53	207,183,996	60·67	1·018	0·573	34·75	233·66	1075	655	76
Total United States	186,396	6·28	25·60	2,163,710,806	65·58	0·986	0·376	26·70	129·78	1351	886	152

TABLE No. II.

	Percentage of railways paying dividends on stock, 1898.											
	No dividend paid.	1 to 2 per cent.	2 to 3 per cent.	3 to 4 per cent.	4 to 5 per cent.	5 to 6 per cent.	6 to 7 per cent.	7 to 8 per cent.	8 to 9 per cent	9 to 10 per cent.	10 per cent. and over	Per cent. of total stock.
New England States ...	20·98	1·82	3·59	0·13	9·50	2·76	16·41	9·19	30·04	0·83	4·75	5·15
North Atlantic States ...	54·05	0·02	0·94	0·45	12·26	17·17	2·55	5·90	3·33	0·22	3·11	19·99
Middle States...	72·67	0·18	0·96	2·08	3·27	3·17	7·78	7·30	1·14	0·07	1·38	13·68
South Atlantic States ...	74·09	9·78	8·11	—	0·96	—	5·79	1·20	0·07	—	—	5·36
Eastern Gulf States ...	76·22	9·79	1·09	0·07	5·32	5·04	1·33	0·03	—	—	1·11	7·13
Middle Western States...	47·51	1·80	3·64	4·42	9·59	17·43	3·25	11·04	0·01	0·17	1·14	16·13
North-Western States ...	62·42	—	1·56	—	28·52	2·09	4·17	0·92	—	—	0·32	4·87
South-Western States ...	85·02	3·69	4·19	5·41	0·76	—	0·75	—	—	—	0·18	12·24
Western Gulf States ...	93·17	—	—	0·59	—	—	—	0·01	—	—	6·23	4·49
Pacific Slope States ...	88·79	5·08	—	—	2·79	2·96	0·38	—	—	—	—	10·96
Total United States ...	66·26	2·65	2·19	1·79	7·15	7·60	3·69	4·54	2·37	0·13	1·63	100·00

TABLE No. III.

	Percentage of Railways paying interest on bonds.											
	No interest paid.	1 to 2 per cent.	2 to 3 per cent.	3 to 4 per cent.	4 to 5 per cent.	5 to 6 per cent.	6 to 7 per cent.	7 to 8 per cent.	8 to 9 per cent.	9 to 10 per cent.	10 per cent. and over	Per cent of total bonds.
New England States ...	8·62	4·49	2·24	7·64	28·89	32·51	8·19	6·94	—	0·48	—	2·75
North Atlantic States ...	5·99	2·65	1·46	4·80	39·86	16·85	18·70	6·93	2·45	0·31	—	20·76
Middle States...	12·19	0·46	1·01	20·37	34·34	14·75	9·14	7·42	0·21	—	0·11	14·43
South Atlantic States ...	6·12	1·36	2·48	1·28	64·91	16·49	4·15	2·67	0·54	—	—	4·68
Eastern Gulf States ...	5·72	2·34	3·99	26·79	28·06	22·64	6·70	3·50	0·26	—	—	9·26
Middle Western States...	10·59	7·55	4·35	20·19	19·57	20·54	10·36	6·56	0·05	0·13	0·11	18·97
North-Western States ...	39·56	—	1·54	—	24·86	27·98	6·06	—	—	—	—	4·88
South-Western States ...	17·26	1·59	0·29	14·05	43·26	14·97	5·99	2·59	—	—	—	11·27
Western Gulf States ...	7·21	7·18	3·91	8·35	40·67	20·69	7·60	4·08	—	—	0·31	4·81
Pacific Slope States ...	12·82	0·99	0·83	18·69	23·83	22·34	19·94	0·09	—	—	0·47	8·19
Total United States ...	11·34	3·06	2·19	14·03	23·37	19·16	11·17	4·89	0·60	0·10	0·09	100·00

The problem of to-day is to keep the unit of cost reasonably below the unit of revenue. At present these two items are much too close together. The passenger receipts averaged 0·77d. per mile.

Again, on the Wabash Railroad, the average revenue per ton per mile for the year ending June 30th, 1899, was but 0·276d., the lowest it has ever reached, while the traffic was heavier than ever. From the figures of the company's report, it appears that it had to carry 15 tons one mile in order to earn 1d. The report also shows that the changes in the character of the goods traffic could not produce this great reduction, and that excessive competition is the only explanation.

Under these conditions, as one of the railway papers has pointed out, the only course open is to reduce the cost of transportation to the lowest possible figure. Maintenance expenses cannot be materially reduced, as the condition of the road and its equipment must be kept up to a high standard if any profit is to be made. Only well-built roads with efficient motive power can hope to make money on the present basis of rates. One of the surest ways in which to reduce the cost of transportation is to increase the train loads. The increase in the average amount of freight hauled per train means a corresponding decrease in the amount of train mileage, and the saving of train mileage means a positive saving of money in fuel and wages.

This condition of affairs in the transportation service is the fundamental reason for the extensive introduction of enormously-powerful goods engines, which has become a striking feature in American railway service within the past few years. It is also the fundamental reason for the expenditures of large sums of money to reduce gradients and curvature. On many railways, particularly —but by no means exclusively—in the western sections, enormous sums are being expended in reducing gradients, improving the alignment, and replacing trestles and timber bridges with permanent structures. The general improvement of the line and the permanent way enables heavier trains to be hauled with greater economy and at less cost for operation, while the permanent structures materially reduce the cost of maintenance. When the railways were built, their location and structures were well suited to the financial and traffic conditions, but with the continual and serious reductions in the rates which can be charged for handling the traffic it has become imperatively necessary to reduce the cost of handling the traffic and the general cost of operating the railways. With older methods of operation under the present goods rates, it would be almost impossible to make any profit, and, as already shown, railway officers have, therefore, had to rise to the occasion, and introduce new and more economical methods of operation. They have recognised, too, that permanence in economy can only be obtained by the judicious expenditure of large sums of money for improvements in the line, and for locomotives and cars of greater power and greater capacity. The consolidation of a number of small lines into larger systems has also been the means of effecting important economies in many cases.

The reduction in rates is due mainly to severe competition and strong public demand, but partly also to adverse legislation and anti-railway movements, and also in part to wilful and inexcusable cut-throat competition between rival lines. In 1880 the average freight rate for the United States was 0·616d. per ton per mile; in 1890 it was 0·475d.; and in 1899 it is but 0·376d.

In passenger rates the reduction has been relatively small, from 1·22d. per mile in 1880 to 0·986d. in 1899. It must be remembered, however, that the accommodation, speed, safety, and service have been greatly improved. In passenger train service great economies could theoretically be made, but practically they are impossible. The train service cannot be cut down below a certain limit, and trains must be run to suit the requirements and convenience of the public. The general use of parlour, dining, and sleeping cars has also introduced additional expense in the handling of passenger traffic. The cars are heavy to haul, have an enormous percentage of dead load to live load, are rarely fully occupied, and the extra fares charged go to the car company, and not to the railway company, the latter only making a mileage charge for hauling. A few roads run their own sleeping and parlour cars. The sharp competition will not allow the quality of the service to be reduced, and this class of passenger service is one of the heaviest items in transportation expenses.

From what has been said, it will be seen that a mere comparison of dividends is not sufficient, but that the conditions of rates and earning capacity must necessarily be taken into account. It would be manifestly unreasonable to expect roads with small earning capacity and ever-shrinking rates to pay as high and as uniform dividends as roads having more favourable conditions in these respects, and which are operated under more stable conditions. If the time comes when freight rates in England fall to any such extent as they have fallen in the United States, then it will be seen whether English railway officers have studied the economics of American railway operation with a desire to learn, or whether they have been content to pass the matter by with somewhat contemptuous criticism. English railways have had many brilliant men in their service, but they have never yet had to contend with such serious conditions as are being contended with by American railways. When that time comes, it will be well for British investors if our managers, directors, and others are able to do as well as their American brethren have done and are doing. This is not written with any intent of disparagement of English railways, railway men, or railway management, but rather to sound a note of warning as to certain possibilities of working in the future.

In another article we shall have something more to say on this subject, and particularly with reference to the possibility of applying certain features of American practice under the conditions which prevail on English railways.

THE THREE-HINGED ARCH.

If judged solely from a purely theoretical standpoint, the three-hinged arch possesses unquestionably, for its own particular type or principle of construction, superior claims to the attention and consideration of engineers over its brothers the two-hinged and the hingeless or fixed-at-the-ends examples. When regarded, however, from a practical point of view, and submitted to the test of actual experience, it does not emerge from the ordeal so triumphantly as might be anticipated, and becomes, in some respects, inferior to the members of the two other types. It may be considered probable that the idea of pivoting or hinging arches took its rise from the necessity of providing some means for preventing cracks occurring in masonry arches, when the centres were struck, and the inevitable sinking at the crown took place to the extent of some few inches. Among other methods suggested and acted upon was that of dressing some of the voussoirs in a particular manner, so as to distribute the whole pressure over a relatively small area, as actually takes place in hinged and pivoted arches. But this plan completely failed in arches of masonry, and a German engineer proposed to replace the rounded voussoir joints by thin sheets of lead, which were to be placed at the "points of rupture," and at the crown, but only bore upon the middle third of the joints. As the line of pressure must pass through this point, it is obvious that the different positions of it, arising from the equal or unequal distributions of the loading upon the arch, would be restricted to very moderate limits. As a matter of fact, the Romans were in the habit of placing sheets of lead in the joints of stonework, and thin leaden plates were used half a century ago in the building of arched bridges of masonry. Layers of asphalt have been inserted for the same purpose at the joints at the crown, and at the springings of arches.

It is about half a century since a French engineer proposed to apply the hinged principle to arches of cast iron, but the original idea was undoubtedly due to Polonceau, prior to that time. Some years subsequently, M. Mantion, in conjunction with M. Darcel, brought prominently forward the advantages to be derived from this method of building arches. It was not, however, until the year 1868 that the principle was put into practical execution by the erection of a three-hinged arch bridge in Austria by M. Dallot, Ingénieur des Arts et Manufactures. This was followed about ten years afterwards by the construction of a triple articulated arch by the Compagnie de Fives-Lille at Saf-Saf, upon the Western Railway of Algeria. In a recent article, alluding to the great development of the arch principle, we mentioned some of the most notable examples of the three classes of hinged bridges, together with their approximate date of erection. We are not at present concerned with this part of the subject, but with that phase of it which deals more intimately with the design of the structure, and with the causes which conduced to the introduction of the principle of the three hinges or pivots. In the designing of arches of masonry, a considerable latitude must be allowed for the uncertainty and want of precise and accurate information respecting the real location of the curve of pressure. Ignorance upon this all-important point obliges the designer to assign to the arch itself, larger dimensions than would be otherwise required, thereby unnecessarily augmenting the quantity of material, the amount of dead load to be carried, and the cost of the structure. Obviously, therefore, if the points where the curve of pressures intersects the crown and the springings could be determined with the proper degree of precision, the problem is capable of a rigorous and exact solution, and will then allow of the material and dimensions being reduced to a minimum. This result can be at least theoretically ensured by substituting for the older type of arch, which was continuous at the crown and fixed—it might be said virtually *encastré*—at the springings, a system of hinges at those three points. The advantages claimed for this method, not only for arches of masonry but also for those of metal, with a few points of difference which do not apply to both classes of structure, and which will be presently alluded to, are briefly the following:—The articulation at the crown and the springings of an arch permits, in the first place, of a comparatively simple and ready method of fixing the position of the curve of pressures, and of the stresses corresponding to every disposition and distribution of either the dead or live load, or the

two combined. So far as arches of masonry are concerned, the same system enables the material, and especially the depth of the voussoirs, to be accurately adjusted to the work they have to do. It is also stated that the result of the adoption of the triple articulation is almost entirely to nullify the effect of changes of temperature. This statement although frequently put forward, is not strictly correct for metallic arches, and even if it be so for the other class, it is practically not worth taking into consideration. It must also be borne in mind that the determination and location of the absolute line of pressure, are, in truth, impossible, unless the assumptions made by the designer are faultless, so that in any case we have to fall back upon the old rule that the stability of the arch will be ensured if the line of resistance fall wholly within the middle third of the arch ring, or of the depth of the voussoirs. If this indispensable condition is incompatible with the form and proportions of any given arch, then both must be modified until it is fulfilled. The best example of an arch built entirely of concrete, upon the three-hinged system, is that at Munderkingen over the river Danube, and is rather a remarkable structure. It has a span of 164ft., a rise of one-tenth of the span, and is built at an angle of skew as sharp as 25 deg. The hinges are not made continuous throughout the full width of the arch, but at each hinged joint there are placed twelve separate semicircular convex bearing blocks 18in. in length, which fit into other blocks which are concave in shape.

There is one application, and one which embraces a very wide field of action, for which the three-hinged arch is exceedingly well adapted. After a certain span is reached in roof construction it is more economical, and also more in accordance with æsthetic considerations, to abandon the rectilineal form altogether and employ that of the arch. One of the largest yet erected was put up for the Manufactures and Liberal Arts Building, Columbian Exposition, Chicago, in 1893. The principal reason why three-hinged arches are peculiarly suitable for the building of roofs is that, neglecting the pressure of the wind, the loading is of a purely static and also of a comparatively light character, which last is a very important detail in selecting them for adoption. Even allowing for the wind pressure, it does not approach either in intensity or in violence the action of the heavy rolling loads to which railway bridges are hourly exposed. Against this description of impactive traffic the triple articulated system is weak, and inferior to both the other hinged types.

Similarly to ordinary horizontal or bow-string plate girders, the arch may have an open or a solid web, but it is not hampered in its field of usefulness by the conditions which speedily put the other forms *hors de combat*. In the case of the solid web arch, the depth of the plate girder is represented by the rise of the arch, which needs no stiffeners or bracing to give it lateral rigidity. There is no particular limit fixed for either type of structure, but for the same span the depth of a horizontal plate girder would be at least five times that of a corresponding arch rib. That the three-hinged arch is affected by changes of temperature will be manifest from the fact that a rise in temperature will cause a proportional rise at the crown of the arch, which will diminish the horizontal thrust, and a fall in temperature will act precisely *vice versâ*, since the abutments are regarded as immovable, and, consequently, the span as unalterable. To bring the subject up to date, it will be sufficient to quote the bridge Alexander III., just erected over the Seine in Paris, as the latest and most finished example of the three-hinged system.

One additional example may here be given, as authorities clearly differ respecting the class of hinged bridges to which it belongs. It is that of the railway bridge over the Theiss, the largest river in Hungary, and is erected in the free town of Szedegin. It has eight spans of 136ft. each, and is a good example of the spandrel-braced type. Rankine observes that the "arches of Theiss Bridge are continuous at the crown, and have flat abutting surfaces at the springings; nevertheless, from the smallness of these surfaces, as compared with the other dimensions of the arch, it is probable that the arches of this bridge also act nearly as if they were hinged at the springing."

From this statement it is evident that the professor was not quite certain in his own mind to what class the structure should be assigned. Assuming his hypothesis, it manifestly should be placed in the second category; but neglecting it, which it is perfectly admissible to do, it must perforce be relegated to the third, or hingeless type. Another well-known authority, Professor Reitter, distinctly terms it a three-hinged bridge, and observes, "That the diagonals in the central bays of the existing bridge have been expanded into a plate web, can hardly be considered a difference in the principle of construction." We do not quite agree with the professor upon this point. One thing is perfectly certain, according to his own statement, which is quite correct, that the open-web spandrel diagonal bracing was removed at and near the crown, and replaced by a solid plate web. The pertinent question that at once presents itself under these considerations is —For what purpose was the slighter open web bracing removed, and a solid plate web substituted, except to impart to the arch that amount of stiffness and rigidity which experience showed it required, and which was not afforded to it by the original open diagonal bracing? Alterations are not made in designs, especially of so important a nature as that of substituting a totally different style of web, without some valid reason, which engenders the supposition that the first must have been found to be defective.

We have been particular in drawing attention to his example, because the best method of uniting arched ribs and spandrel bracing has yet to be discovered, and until it is discovered, that type of three-hinged arch will not compete successfully, in point of rigidity, in cases where the traffic is frequent and heavy, with either of the two other types.

BRITISH AND AMERICAN MACHINE TOOLS.

NO. II.—THEIR COMPARATIVE EFFICIENCY.

THERE is one factor which largely contributes to the success of the Americans in the manufacture of machine tools, which, apart from all other considerations, tends to the design and production of a highly efficient article. This is the system which many firms are now adopting of specialising and confining their attention to the turning out of large quantities of machines in small variety.

In this the older country, whose factories first came into existence when the practice of engineering was in its infancy and the various branches of this industry were not so defined as they are now, it was necessary for a firm to undertake a general class of work which would meet all requirements, and our engineers having successfully carried on a general trade for many years, are perhaps disinclined to adopt new methods.

Thus the prevailing belief has been that a firm employing a large number of hands, in order to obtain sufficient trade to keep its works in full operation, is obliged to undertake the manufacture of a certain variety. Of late the American has recognised the fact that if he can only produce a limited variety of machines at a lower cost and of greater merit than his competitors, he will obtain a reputation for his special class of work, and command a sufficient trade in these alone to keep his works fully employed, and enable him to earn a fair interest on his capital, without the complications and expense which are necessarily entailed by the manufacture of a large number of different classes of machines in one factory.

Thus several comparatively new firms have sprung up in America, many of which have already obtained a high reputation, among whom we find one confining itself to the manufacture of milling machines, another producing planing machines, a third lathes, a fourth drilling machines only, and so on. As an illustration of this, we will take the case of a firm which restricts its manufacture to milling machines. This concern makes two classes of milling machines, and two sizes of each. It also manufactures a machine for grinding milling cutters; five different tools in all. It turns out twelve to fourteen milling machines a week, averaging in value about £100 to £110 each; and, having obtained a well-deserved reputation, is not only maintaining but rapidly increasing its trade.

On the ground of efficiency alone, it is easy to see that there is a great deal to be said in favour of this system of manufacture. The practical engineers and designers, having to confine their attention to a limited number of tools, instead of exercising their brains on an endless variety, as a natural result become especially expert in their particular line. More consideration can be given to details than is possible when a large variety has to be dealt with; especially when draughtsmen are working against time to fulfil a pressing order, embracing a number of different machines. There is less hesitation in altering drawings and patterns to effect an improvement, as this can be done at comparatively little sacrifice when it is tolerably certain that the expense of alteration will be spread over a large number of machines, which are likely to be purchased within a reasonable time of their being completed. Further, a concern working on these lines has better opportunities of noting and adopting any new improvements brought out by its competitors, than one which undertakes the manufacture of every type of machine tool.

Anyone acquainted with first-class American machines made on this system cannot fail to be struck with the excellence of their arrangement, and the care which has been given to the smallest detail. The convenience of the workman is studied in every point. All movements are controlled by levers or handles, placed in convenient positions, and so arranged that the operator can adjust his machine without taking his eye off the work. Suitable cupboards are provided in the main casting for containing small loose parts, such as spanners, change wheels, &c. All working surfaces are protected as far as possible from dust. No oil-holes, even on slow-running spindles, are left exposed, improved lubricators, readily adapted for oiling up without loss of time, being provided. All guards are made so that they can be readily detached and refixed with the least possible delay. All wearing parts likely to require adjustment are easy of access. Special appliances are introduced for readily changing the speeds of the machine. These points individually, perhaps, appear of small importance, but, taken together, make a large difference in the productive capacity of a machine. It is not, of course, contended that all English makers neglect these small details, or that no inferior machine tools are manufactured in America; but, comparing the best tools produced by both countries, the American machines, taken as a whole, give evidence of having been more carefully considered with respect to small conveniences than those manufactured in this country.

The great success achieved by the special American lathes for the manufacture of bicycle parts in this country is another proof of the efficiency of American tools, when manufactured by specialists, and the acknowledged superiority of the latter over the English machines in this respect has, in a large measure, assisted the importation of American tools of every type in this country during the last few years. The excellence of American machines of the lighter type is now generally admitted, but there are many who maintain that in the heavier tools the Americans are behind us in point of efficiency. In the manufacture of medium and heavy lathes for general work there is no doubt that this country at the present moment maintains its superiority. But, as regards milling machines, planers, drilling machines, shapers, key-seating machines, boring machines, and, in fact, almost every other class of machine tool, whether for light or heavy work, America now approaches us very nearly in excellence of design and manufacture.

There is a general impression that the American tools

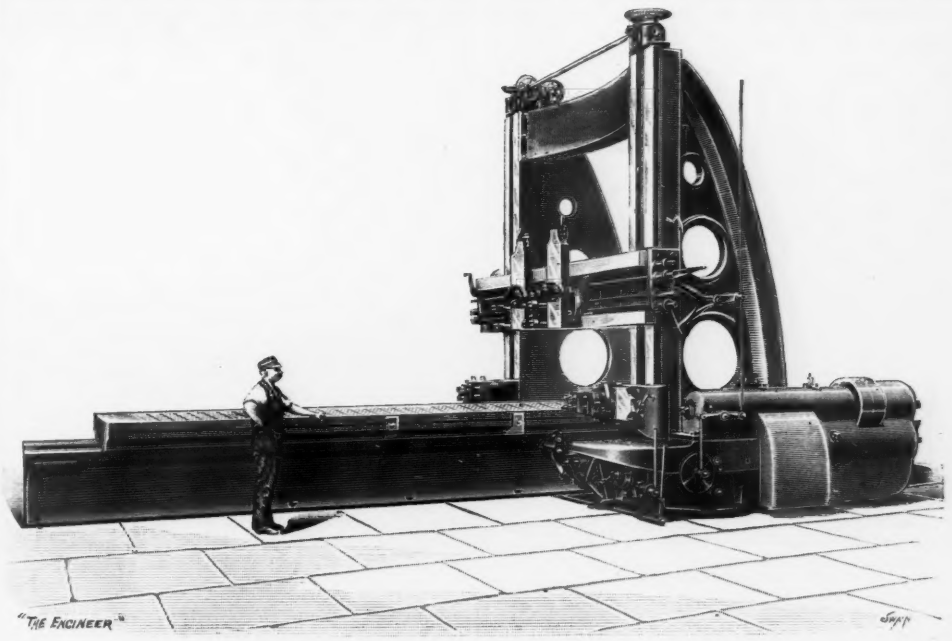


Fig. 1—AMERICAN PLANING MACHINE

are considerably lighter than the English, and not strong enough for the work they have to do. In many small machines no doubt the total weight of the corresponding English tool is, usually, the greater, but the larger American tools for heavy work are, as a rule, very massive and powerful. In the case of two quotations recently received to identical specifications for a large machine tool, one from an English, the other from an American firm, both of the highest standing, the machine offered by the English house turned out to be lighter in weight by more than two tons than that offered by the American firm, and in all details the latter machine was the stronger.

In the manufacture of planing machines, both large and small, the Americans especially excel. These tools are well designed, the framework is massive, and the mechanism powerful. The return motion of the table is quick—in some cases in small machines as much as 150ft. per minute—and the reversing is effected without any jerk, the travel of the table being smooth and even. Fig. 1 is an illustration of a large planer, which is fairly representative of this type of machine as manufactured in America.

It would be tedious and unnecessary to compare every class of American tool with its English fellow, but there is one tool of American manufacture which deserves special notice, and which is rapidly finding favour among engineers in this country. This machine is known as the vertical boring and turning mill for heavy work, which we have already had occasion to illustrate in these columns. In America its advantages are so universally recognised that it has practically superseded the large face lathe altogether. Though English machine-tool makers have manufactured this class of machine for some years past, the majority are still selling the face lathes, and most of the large vertical boring and turning mills in use in this country have up till now been supplied by American makers.

The chief advantage which this machine possesses over the face lathe is that the work can be fixed and centred with far greater rapidity. In the case of the latter machine, the work being attached to a vertical

face-plate has to be supported while being fixed. When heavy castings have to be handled the shop traveller is in requisition for this purpose, and, if the casting is an awkward shape, the fixing of the work is sometimes a matter of two or three hours; thus, not only is the machine itself at a standstill during this period, but the wages of the man working the traveller are added to the cost of the operation. Moreover, the traveller is not available for other machines which meanwhile, perhaps, are waiting for its services. By the use of the vertical boring and turning mill this delay and expense are largely done away with. The work to be machined is lifted on to the table in a few minutes, after which the traveller is no longer required, and the operator can complete the fixing of the job without its assistance.

Moreover, as the table supports the work, considerable time is saved in the fixing, as very little cramping down is required to keep the casting in place while the table is rotated, to enable the operator to centre his job. In the case of the face-lathe, the work must be securely fastened before the machine can be set in motion.

In addition to these advantages, the table of the vertical mill being horizonal, every portion of it is accessible to the workman, which is not the case with a vertical face-plate 6ft. or 8ft. in diameter. As the illustration shows, the vertical boring and turning mill is provided with two tool-holders, one of which can be used as a boring tool, while the other is turning the circumference, and both holders are provided with canting movement, so that fly-wheels and pulleys can be turned with a crown face if required. When used for repetition work, formers can also be applied to this machine, as in the case of the ordinary lathe. In fact, in nearly every instance where heavy castings have to be turned or bored, this type of machine will perform its work far more rapidly than is possible when using a face lathe of the most improved design.

The American system of specialising in manufacture has, to a large extent had the effect of specialising the machine tools themselves, and consequently, as a class, the American machines are not generally so well adapted for a large variety of general work as those of English design. A considerable proportion of American tools are built solely for the purpose of turning out a large amount of repetition work at a high speed. This makes them particularly valuable to purchasers who can keep them fully employed, but these special machines, unless used for turning out large quantities of one article, are somewhat costly to work, in that they often require an expensive supply of special tools, and take considerable time in adjusting for any particular job. One is apt to lose sight of this fact when seeing them in operation in someone else's factory; and before purchasing, it is well to consider whether the amount of repetition in one's own factory is sufficient to warrant the outlay, as, under existing conditions, a machine which can be employed for general purposes will frequently be found more convenient. On the other hand, after having purchased a machine of this description, it is often possible with a little care slightly to modify one's drawings so as to create a demand for repetition articles, and thus the special machine may be employed to advantage.

There is one important tool to which the Americans have devoted a good deal of attention, and which up to the present appears to have altogether escaped the notice of English manufacturers. This is an efficient machine for grinding up turners' tools. In every English workshop visited by the writer, where a machine of this description is in use, it has proved to be a tool of American make; but in most engineers' shops in this country the ordinary grindstone is to be found in use for this purpose, and in many cases each workman is allowed to grind up his own tools. This is a mistake. It is obvious that on whatever class of work a tool may be employed, its shape should be such that the best results are obtained both as regards cutting speed and durability of cutting edge. It is therefore desirable that, having arrived at the exact shape which will best fulfil these requirements, this form of tool should be maintained. When each man is permitted to sharpen his own tools on a grindstone this is impossible, as often, through carelessness or ignorance, a man will grind his tool to a shape quite unsuited to the work which he is doing. Two or three American firms manufacture a machine requiring practically no skill to work, by means of which all the various tools in use in an ordinary machine shop can be ground to any shape or angle, and an illustration of which we gave last week. The operator is provided with a table on which full-size drawings of the various kinds of tools in use are shown with their proper angles figured on, and with this before him, he is able to sharpen each in turn, and grind it to its proper shape. The tools when ground are put into the stores to be given out as required, and thus no time is wasted on account of the machines being at a standstill while the workman is engaged at the grindstone. A tool-grinding machine of this description will keep a good size shop of machine tools going, as it will grind up ready for use from 200 to 400 tools of various shapes in a day.

As before mentioned, these machines are being adopted by many engineers in this country, and it seems a pity that they are not yet obtainable from any of our English manufacturers.

TESTING CABLES.—The Dudley Chamber of Commerce have sent to the Chambers of Commerce of the Midland district a circular inviting attention to the new Anchors and Chain Cables Act of 1899. The Chamber commend it, and point out that the law on the question is, by the new Act, made perfectly clear; and stating that it rests with the maker, buyer, and user of anchors and chain cables, and also of chains, of the various kinds in use, to see that its provisions are properly observed. The new Act provides for the granting of testing licences to the Committee of Lloyd's Register of Shipping; for public testing establishments at Netherton, near Dudley; Tipton; Saltney, near Chester; Glasgow; Low Walker, Newcastle-on-Tyne; and also at Sunderland and Cardiff; and the Act provides that all anchors and cables for the use of any British ship must be tested at one of the public proving houses, and certificates of test duly issued.

LITERATURE.

Handbuch der Ingenieurwissenschaften. Zweiter Band. Der Brückenbaun. Erster Abtheilung. Bearbeitet von R. BAUMEISTER, F. HEINZERLING, TH. LANDSBERG, FR. LOREY, G. MEHRTENS, G. TOLKMITT, herausgegeben von TH. LANDSBERG. Third Edition. Large 8vo., pp. 578, with 306 text figures and 30 plates. Leipzig: W. Engelmann. London: Williams and Norgate. 1899. Price £1 4s. sewed, £1 7s. bound, net.

THIS is a new issue of the second section—that dealing with bridge building—of a well-known encyclopædic work on civil engineering construction, and in great part the arrangement of the material is similar to that of the preceding edition, which appeared in 1886; but, as may be readily imagined, owing to the rapid progress in this branch of engineering, very considerable additions have been made; and the lapse of time has also led to changes in the editor and contributors, the work being now under the charge of Professor Landsberg, of Darmstadt, with a distinguished body of architects and engineers as coadjutors, whose names are given above. Although called the first part of the second volume, it is essentially a complete work, dealing with six different subjects, which are treated in succession as follows:—The first chapter, on "Bridge Building in General," by the editor, is a review of the whole subject, including its historical development, the principle of bridge design, selection of method of construction, and a summary list of the more important existing bridges, classified according to size. The second chapter, by Baurath Tolkmitt, describes the various forms of stone bridges and the theory of their design; while the third, by Professor Mehrtens, of Dresden, gives in considerable detail the methods of building and maintaining stone bridges—apart from foundation works,—including a section on costs and accounts; and as these are matters which are usually somewhat imperfectly treated in such works, we are inclined, without in any way depreciating the work of other contributors, to consider it the most valuable section from the practical point of view. In the fourth chapter Professor Heinzerling gives us a careful and well-written summary of the principles and details of wooden bridge building, a subject which, however, is now necessarily more of historical than immediate technical interest, except as regards military and other temporary bridges, which are duly noticed. In the fifth chapter, by Herr F. Lorey, of Darmstadt, on "Canal Bridges and Aqueducts," we find some interesting details of the construction of the river crossings of the Dortmund Ems Canal, in which the waterway is formed by close-boarded wooden troughs, rendered water-tight by lead packing backed with asphalt and cement. The sixth and last chapter, which is one of the longest in the book, by Professor Baumeister, of Karlsruhe, deals with a somewhat controversial matter, namely, the æsthetics of bridge building, but in a very judicial spirit; the relation between the constructive and ornamental values of the different elements making up the complete structure being discussed in detail, with the assistance of a large and well-chosen series of examples from all parts of Europe. From the above rapid glance at the contents, it will be seen that the volume is essentially one on all kinds of bridges, other than those in iron, which latter class, together with movable and suspension bridges, and the construction of metallic piers, as well as the erection and maintenance of such structures, form the subjects of the four remaining divisions of the work. According to the statement of the preface, these are well advanced, and will soon be completed.

Transactions of the Institution of Mining and Metallurgy, London. Eighth Session, 1898-99. Vol. VII. Edited by ARTHUR C. CLAUDET, A.R.S.M. London: The Institution of Mining and Metallurgy, 1899; pp. 346.

THIS volume contains twenty-five papers, with discussions; the address of the President, Mr. J. Herbert Cox; the report of the council, and a statement of funds. Both the financial portion and the numerical strength of the Institution are recorded as in a flourishing and progressive condition.

In the President's address it is announced that the membership is to be kept rigorously exclusive, but that by the payment of a guinea a year persons not elegible for membership may receive the "Transactions," and attend the meetings. Furthermore, it is remarked that the principal duty of a mining engineer is to further establish mining as an industry, and to eliminate the speculative element as much as possible, and many interesting and important examples are cited from every quarter of the globe to demonstrate that that laudable object is being successfully achieved in many localities. As regards new processes, the following words of wisdom are added, "Every process may be of value for one particular class of ore, and specially applicable to one mine or group of mines, but no process can exist which is capable of universal application." We heartily agree with the President, both as regards the correct duty of the mining engineer, and his views about new processes, although we should like to add in the latter case—as far as our present knowledge goes.

As regards the contents of the papers there is the usual variety of subjects, and the usual cosmopolitanism observable. Mines and mining of gold, copper, tin, silver, asbestos, mica, lead are dealt with, and include:—Cornwall, the Witwatersrand, the Malay Peninsula, the Lake Superior region, Bolivia, Victoria, New South Wales, Bengal, Grigualand West, Norway, British Columbia in the regions discussed; then there are papers dealing with concentration of ores, with dry and wet crushing—always a contentious subject—with the treatment of slimes, with the cyanide process, with the Godfrey mechanical calciner, with an improved muffle furnace, and some other subjects.

Most of the papers take the form of useful notes, but some, such as Mr. A. K. Camming's, "The Lucknow (N.S.W.) Goldfield," and Mr. J. D. Kendall's, "The Silver-head Deposits of the Slocan, British Columbia," are extensive treatises, however, in all cases more or less of a discussion follows the paper in which is set forth the views of various prominent members and their friends upon the matter considered.

There is no doubt that those in search of information on the various subjects treated would find the consultation of these "Transactions" profitable, and although the index leaves much to be desired, the volume, like others that have appeared under Mr. Claudet's skilful direction, has the usual nicely-finished appearance.

Projectirung und Veranschlagung von Flusobefestigungen. —Von R. WILLIAMS. Small folio, pp. 65, with six illustrations in the text, and twelve plates. Leipzig: W. Engelmann. London: Williams and Norgate, 1899. Price, 8s. net.

THIS is a short practical treatise upon a difficult point of hydraulic engineering, namely, the regulation of rivers flowing through flat ground in tortuous channels whose banks are subject to heavy and irregular erosion in flood time, especially at points of sudden change of curvature, whether in direction or amount. For such places where the sides and bottom of the channel require protection by stone pitching, concrete, or other methods of surface defence, the author has devised a method whereby the form and position of such protective works can be readily determined by graphic construction upon the plans and sections of the preliminary river survey, and this, together with the theoretical basis, is described in the introductory pages, the application being illustrated by the study of a particular case.

The work is based upon observations made in the preliminary investigation of a scheme for regulating the length of about ten miles of the Elster river in Saxony, and the methods proposed to be adopted for filling holes in the bottom of the channel and protecting the slopes are fully gone into, for an S-shaped section of the river of about 220 yards in length, according to seven different methods. Among these are included two systems of stone pitching, ordinary and Monier concrete slabs, and the use of wire netting in combination with piling in the hollows, which have been successfully adopted in the regulation works of the Upper Rhine, where the river carries large quantities of loose and heavy gravel. Full estimates, both as regards quantities and prices, are given with each project, and these details, together with the necessary plans and sections, occupy the greater part of a book which cannot fail to be of value to the specialist, to whom it is more particularly addressed. In the final section the author gives an interesting application of his method to the testing of the principle laid down by Fargue in 1868, as the results of the study of a length of about fifteen miles of the course of the Garonne, namely, that the positions of the points of greatest depth in the bottom of a channel of irregular section may be deduced from the form of the surface, and shows that it is fairly well borne out by the results of the Elster surveyor.

BOOKS RECEIVED.

The Royal Navy List Diary and Naval Handbook for 1900. London: Witherby and Co. Price 3s. net.

The Statistical Year-book of Canada for 1898. Fourteenth year of issue. Issued by the Department of Agriculture. Ottawa: Government Printing Bureau. 1899.

The "Mechanical World" Pocket Diary and Year-book for 1900. Thirteenth year of publication. Manchester and London: Emmott and Co., Limited. Price 6d. net.

Leçons sur l'Electricité professés à l'Institut Electrotechnique Montefiore annexé à l'Université de Liége. Par Eric Gerard. Tome Second. Sixième edition. Paris: Gauthier-Villars et Fils. 1900.

The Useful Arts and Handicrafts Series: No. 2, *Wood-carving for Beginners.* By Charles Godfrey Leyland, M.A., F.R.S.L., &c., and "Jack-Plane." Price 6d. net. London: Dawbarn and Ward, Limited.

City of Manchester—Rivers Department: Experts' Report on Treatment of Manchester Sewage. Dated October 30th, 1899. With plans, views, and diagrams. Manchester: Henry Blacklock and Co., Limited. Price 5s.

The Metallurgy of Lead and Silver. By Henry F. Collins. Part I. Lead. Edited by Sir W. C. Roberts-Austen, K.C.B., D.C.L., F.R.S. With numerous illustrations. London: Charles Griffin and Co., Limited. 1899. Price 16s.

The Kinetic Theory of Gases. Elementary Treatise with Mathematical Appendices. By Dr. Oskar Emil Meyer. Translated from the second revised edition. By Robert E. Baynes, M.A. London: Longmans, Green, and Co. 1899. Price 15s. net.

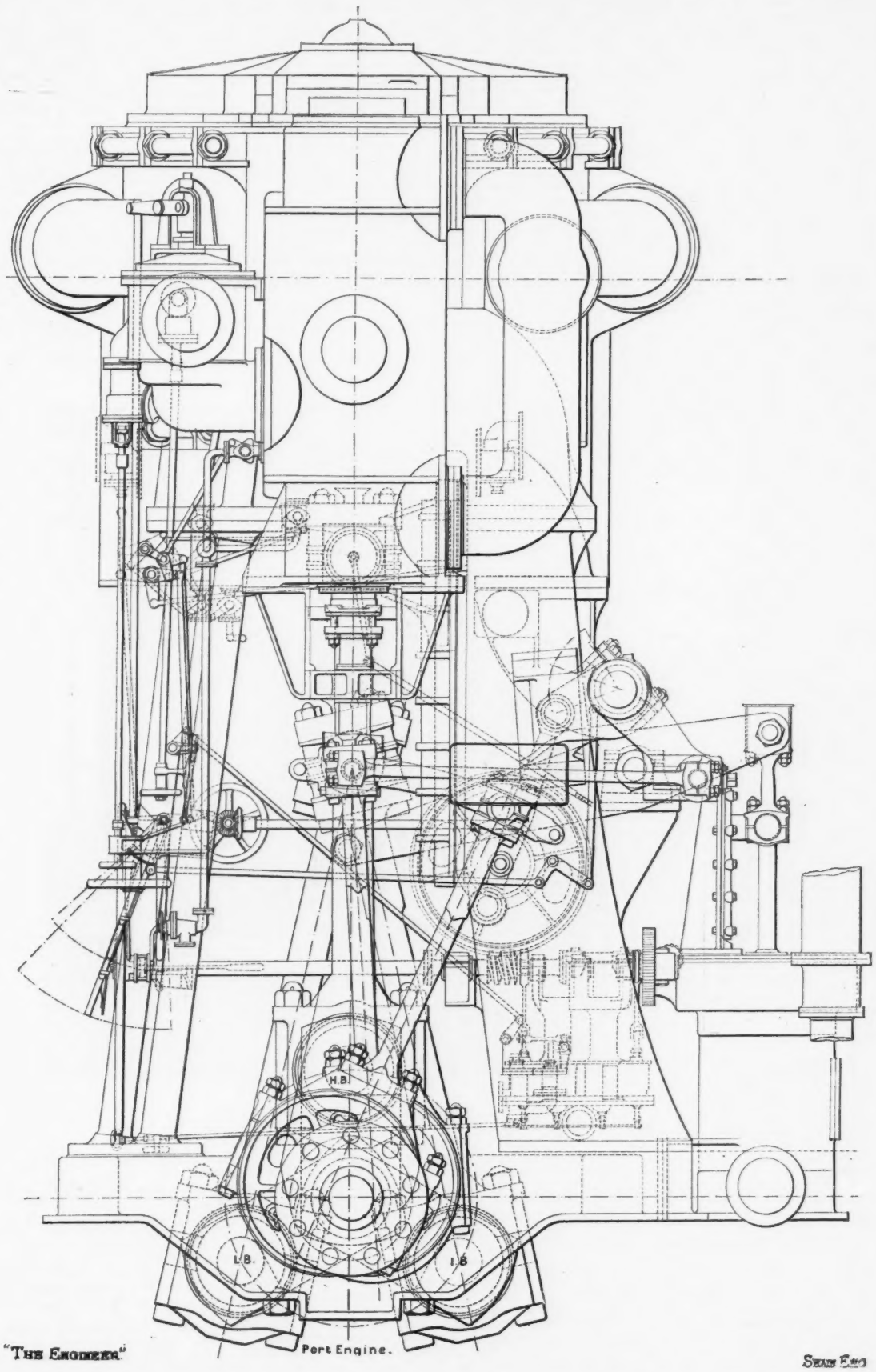
Traité de la Fabrication des Liqueurs et de la Distillation des Alcools. Par P. Duplais ainé. Septième édition, entièrement refondue par Marcel Arpin, Ernest Portier. Tome Premier, Les Alcools. Tome Second, Les Liqueurs. Paris: Gauthier-Villars, 1900.

The "London Letter" War Directory. Revised up to date. Containing about 3000 names of Naval and Military Officers and the Nursing Staff serving, or requisitioned to serve, in South Africa, with notification, up to date, of the Officers who have been killed, wounded, and taken prisoners. London: The *London Letter* Publishing Co., Limited. Price 6d.

STRAND IMPROVEMENTS.—The Improvements Committee of the London County Council have reported to that body that nearly all the property fronting the Strand between St. Clement Danes Church and St. Mary-le-Strand Church, and needed for the widening of the Strand, has now been acquired, and the committee have arranged for the immediate acquisition of the remaining property. It may not be possible or expedient for some time hence to remove entirely the whole block of buildings lying to the south of Holywell-street, but the committee says that it can at once arrange for the widening of the Strand to 70ft., which will be a great convenience for the traffic in this part of the Strand. A large hoarding or some inexpensive lattice-work will be erected on the north side until the remaining portion of the improvement, involving the demolition of the houses in Holywell-street, can be executed. The committee have given the necessary instructions for the pulling down of the houses forming the northern frontage of the Strand, and hope to bring up, in the course of two or three weeks, a recommendation dealing with the execution of the paving works, which will, it is hoped, be completed by about March next. The Council, at their meeting on Tuesday last, approved of the action of the Improvements Committee.

TRIPLE-EXPANSION ENGINES, H.M.S. OCEAN—END ELEVATION

R. AND W. HAWTHORN, LESLIE, AND CO., LIMITED, NEWCASTLE-ON-TYNE, ENGINEERS



"THE ENGINEER" Port Engine. STEAM END

ENGINES OF H.M. FIRST-CLASS BATTLESHIP OCEAN.

OUR Supplement illustrates the machinery of H.M.S. Ocean, which was launched on July 5th, 1898, at Devonport. The engines are of the triple-expansion type, steam being supplied by Belleville boilers. The following tabular statement gives the principal dimensions.

Principal Particulars.

High-pressure cylinder	30in. diameter
Intermediate-pressure cylinder	49in. ,,
Low-pressure cylinder	80in. ,,
Stroke	51in. ,,
Air pump	26in. dia. 24in. stroke
Connecting-rod centres..	8ft. 6in.
Crank shaft, diameter	16½in.
Main steam pipe, diameter	12½in.
Cooling surface	7250 sq. ft.
Steam pressure	250 lb. per sq. in.

The propelling machinery consists of two complete sets of triple-expansion three-crank engines, having a collective indicated horse-power of 13,500. Steam is supplied by twenty Belleville type water-tube boilers fitted with economisers, the working pressure being 300 lb. per square inch reduced to 250 lb. at engines. The whole of the machinery and boilers has been designed and constructed by R. and W. Hawthorn, Leslie, and Co., Limited, St. Peter's Works, Newcastle-on-Tyne.

The diameters of the three cylinders are respectively:—high-pressure 30in., intermediate-pressure 49in., low-pressure 80in., the stroke being 51in. The cylinders are of cast iron, each being a separate casting. They are braced together by wrought steel stays fitted at top and bottom, and each one has a separate liner forming a steam jacket. They are, of course, inverted, and are carried at the back on columns of box pattern, spread in Y shape at the bottom to give greater stability. This column also carries the motion bars. The front pillars are of forged steel two to each cylinder. This arrangement leaves the front of the engine open and gives ready access to working parts. The valve of the high-pressure cylinder in each engine is of the piston type, while those of the intermediate and low-pressure cylinders are of the double-ported flat type. These valves are worked by double excentric link gear, the ahead rod being as usual the straight rod. The engines are reversed by an independent double-cylinder steam reversing engine, working a worm and worm wheel of the all-round type, clutch arrangement being fitted so that the engines can be reversed by steam or hand.

There are for each engine two lengths of plain shafting, one thrust shaft, one stern tube shaft, and one propeller shaft, the total length being 124ft. The thrust block, although placed in the after end of engine-room, is not attached to the main engine bed-plate, but is fitted on a strongly-built independent seat, so that fore and aft load cannot be transmitted to the engine bed-plate frames. The thrust surface is 1800 square inches for each engine, and there are nine cast steel collars of the usual adjustable horse-shoe type, lined with white metal. The thrust block itself is of cast iron, and has a plain bearing immediately forward and aft of the thrust collars. The intermediate shafts are

15½in. external diameter, with 8¾in. hole, supported at intervals by plummer blocks lined with white metal. The stern tube shafts are 18¾in. diameter over liners with 9in. hole, and have lignum vitæ bearings 3ft. and 4ft. long at the forward and aft ends respectively. The propeller shafts are 17½in. external diamater with 10in. hole, the outer bracket having a lignum vitæ bearing 6ft. 6in. long. The screw propellers are each four-bladed, of gun-metal, and are secured to a gun-metal boss; the diameter over the tips of the blades is 17ft. 3in., with a pitch of 19ft. 6in., which is variable from 18ft. to 21ft. The condenser for each engine is placed in the wing of the ship. It is of gun-metal, with horizontal tubes of brass, through which the circulating water passes. The cooling surface in each is 7250 square feet. The air pump, which is worked by levers from the intermediate-cylinder crosshead, is entirely of gun-metal, is single-acting, and is 26in. diameter, and 24in. stroke. The foregoing description will render the accompanying drawings clear to the reader, and enable him to readily understand the design.

The boilers, as already stated, are twenty in number, of the Belleville type, and contain many important modifications in detail which the Admiralty, by their extended experience of these boilers, have been able to suggest. They contain a total heating surface of 33,770 square feet, and a grate surface of 1058 square feet. Of the above-mentioned heating surface, 12,012 square feet is in the economisers. Before being fitted on board the vessel, two of the boilers were steamed in the works of the makers. When burning 30 lb. of coal per square foot of grate surface, an evaporation of 11·67 lb. of water, from and at 212 deg., per pound of coal resulted. All feed regulators, feed pumps, furnace air blowers, &c., were steam tested before being put on board. The boilers are arranged in three water-tight compartments, viz., eight boilers in each of the two forward rooms and four boilers in the after room. The sea trials specified, of which particulars follow, were three in number, viz.:—Thirty hours at about 2700 indicated horse-power; thirty hours at about 10,250 indicated horse-power; eight hours at full 13,500 indicated horse-power. All these were completed to the satisfaction of the Admiralty inspecting officers. The last of the series, viz., the eight-hours' full-power trial, took place on October 30th last, when a mean indicated horse-power of 13,828 was obtained with 113 revolutions per minute. The whole of the machinery worked well, and gave no trouble. The vessel, of course, is installed with the full complement of auxiliary machinery necessary for the efficient working of a modern first-class battleship. This installation has been obtained partly from manufacturers on the Admiralty list, and has been made partly by Hawthorn, Leslie, and Co., themselves.

	Average of 30 hours, 27th & 28th July.	Average of 30 hours, 2nd & 3rd August.	Average of 8 hours, 20th Oct., 1899.
Air pressure	Fans not working	Fans running 130 revs. No air pressure	Fans running 177 revs. Air pressure ·07
Vacuum—			
Port	27·5	26·2	27
Starboard	27·8	27·0	27
Steam pressure in stokehold	210	267	272
Steam pressure in engine-room	184	221	223
Revolutions—			
Port	67	103·1	114·5
Starboard	66·6	101·9	111·1
Receiver pressure—			
H.P., Port	165·3	221	228
,, Starboard	167	216	224
I.P., Port	26·2	52	78
,, Starboard	26·2	54	71
L.P., Port	14·1	5·9	14
,, Starboard	13·6	9·8	12
Indicated horse-power—			
H.P., Port	466	1,562	2,170
,, Starboard	506	1,854	2,0 9
I.P., Port	501	1,763	2,442
,, Starboard	527	1,776	2,501
L.P., Port	369	1,459	2,306
,, Starboard	398	1,600	2 390
Total	2767	10,314	13 828
Speed	*11·4 app.	*16·2 app.	†18·74
Number of boilers in use	8	20	20
Coal consumption per I.H.P.	1·84 lb.	1·63 lb.	1·76 lb.

* Ship foul. † Ship clean.

H.M.S. SUTLEJ.

On the afternoon of Saturday, 18th ult., John Brown and Co., Limited, Clydebank, successfully launched the Sutlej, one of the two armoured cruisers of the Cressy class they are building for the British Government. In two respects the function was notable. Not only was the launch the first since the change in the designation of the famous firm, but the vessel was the first of six of a similar type to leave the ways—and that a new type—now under construction in private yards. In the original distribution of the work, two vessels, the Cressy and the Aboukir, were placed with the Fairfield Company; one, the Hogue, at Barrow; and one, the Sutlej, at Clydebank; but subsequently the Admiralty ordered duplicates—the Bacchante from Clydebank and the Euryalis from Barrow—bringing the total up to six vessels. Of the six, therefore, Clydebank's first vessel of the class is earliest in the water, but the Cressy, which really gives the name to this particular type of cruiser, though not yet launched, is at least equally well advanced at Fairfield, and will, in fact, be sent off the stocks on the afternoon of Monday, 4th prox. The race to completion between the Fairfield and the Clydebank productions should be interesting. The Barrow cruiser, the Hogue, will not be floated probably before the spring. The Cressys are practically Diadems without the weakness involved in the absence of side armour, and with a main armament disposed somewhat on the same lines as the Terrible's. The merely protected vessels of the Diadem class are 435ft. long and 69ft. broad, while the armoured cruisers are 440ft. long between perpendiculars and 69ft. 6in. beam. The one class displaces 11,000 tons, while the other's displacement is 12,000 tons on a draught of 26ft. 3in.; the difference being due, of course, to the extra 1200 tons of side armour.

As to the arrangement of decks below the protective deck, which is about the level of the load-line, there are the two usual flats at the forward and after ends, with platforms for magazines, &c.; and above the protective deck, which is curved, there is, forward and aft, a level platform to make this armoured deck useful. Above that there is the main deck right fore and aft, and above that again the upper deck, and over it a boat deck on either side of the ship, and on the same level as the forecastle head. There are navigating bridges forward and aft, the latter forming a large shelter over the continuation of the boat deck. All the ships of the class are similar in their construction, with double bottom, and framing on the longitudinal system, now usual in the Navy. The ship will be sheathed with teak 4in. thick, and covered with copper, like the Canopus.

As to the broadside armour, it consists of a belt 11ft. 6in. deep, extending 5ft. below the water-line and 6ft. 6in. above it. This armour, which is 6in. thick, extends for a length of 230ft., terminating 120ft. from the bow and 90ft. from the stern in athwartship bulkheads, which are 5in. thick. Thus the central part of the ship forms a citadel, from within which the fighting will be carried on. The side armour is backed with 4in. of teak, so that with the wood sheathing and the ordinary shell plating, the total thickness at the load-line is 15in. The protective deck curves to the bottom of the broadside armour 5ft. below the water-line, and in the centre line of the ship it is 1ft. above the load-line. In the wake of the machinery it is curved still higher, to enable the engines to be entirely below the protective deck. The thickness of the deck is 1½in. within the citadel and 3in. at either end of the ship. The main deck has also been made of unusual thickness to assist in the protection. But even at the extreme forward end of the ship there is also broadside armour, although of less thickness than the main belt. It is of 2in. nickel steel, specially hardened, which has been found on trial to stand a very severe trial from 6in. guns. This belt is 14ft. 6in. deep, and extends from the athwartships bulkhead already referred to.

The speed of the Sutlej and her compeers of the Cressy class will be 21 knots, with 21,000 indicated horse-power, and 120 revolutions. The engine cylinders are 36in., 59in., 68in., and 68in. diameter, the stroke being 48in. There are thirty Belleville boilers, fitted with economisers, and the working pressure is 300 lb. per square inch, reduced to 250 lb. at the engines. The four compartments into which the boiler space is divided absorb 130ft. of the length of the ship, as compared with 132ft. in the Diadem class, and 186ft. in the Powerful and Terrible. In the forward boiler-room there are six boilers, and in the three other compartments eight boilers in each, arranged, of course, with the tubes fore and aft. The bunkers are on each side of the boiler-rooms under and above the protective deck, and, as is the custom in building all ships now, there is an ammunition passage immediately below the protective deck. There is an athwartship bunker right forward.

The main armament of the vessels will resemble that of the Powerful rather than the Diadem. The latter has two 6in. 7-ton guns on the forecastle with shields, and two of the same calibre on the upper deck firing aft. Like the Powerful, the Sutlej and others of the Cressy class will have instead a 9·2in. 22-ton gun firing ahead, and one firing astern, but with this important difference, that in the Cressy the weapons will be mounted in barbettes with 6in. armour, the guns, as formerly, being protected by shields. The 9·2in guns, fire a 380 lb. projectile, with a muzzle energy of 14,520 foot-tons, so that the Cressy cruisers will do effective duty when chasing an enemy or fighting in the line, for both guns have a large arc for broadside attack. Again, four 6in. guns firing 100 lb. shot, are arranged in casemates to fire ahead in line with the keel, and four to fire astern; and these also can fire on the broadside at almost any angle. There are also four guns amidships on the main deck, two on either side. There are, in addition, distributed throughout the ship, twelve 12-pounders and a large number of machine-guns. The Sutlej and her sisters will have four funnels and two masts, with a top on each for carrying search-lights, but no guns, and with the usual semaphores.

LAUNCH OIL ENGINE.

The oil engine is endeavouring to come to the fore as a means of propulsion for small river craft, and it seems to be faily well suited for the purpose. At all events it has been successful in a good many instances. We have recently been invited to inspect and examine a launch which the Griffin Engineering Company, of Bath, has not long completed. We had an opportunity of having a long run on the Thames with this vessel. It was labouring under a disadvantage at the time. It had been brought up to London from Bath by canal—a lengthy job necessitating passing through some 120 locks on the way. In one of these, when the Thames had nearly been reached, the water was so low that in passing through, the launch's propeller, or one of them—for there are two—had touched the sill of the lock or something on the floor of the lock, and had lost one of its three blades. This accident had happened at such a time that our visit could not be postponed, and the trial was carried out with the damaged screw. In spite of this the launch behaved uncommonly well.

As we have already said, there are two propellers. With the engine running always in one direction, it was possible with the two propellers, one of which has the pitch in one direction and the other in the other, to run either ahead or astern, by the simple movement of a lever. The advantages claimed for this are many. For instance, the boat can be started, stopped, and reversed by the motion of a single lever without stopping or reversing the engine, driving shaft, or any part of the mechanism. There is no shock when the propellers are disconnected or put in motion. There are no cogs, racks, or gearing of any kind. There is stated to be no obstruction to the movement of the boat when the propellers are out of action, which is said to render the boats so fitted specially suitable for canals. The operations of starting, stopping, reversing, and steering can be controlled by one man seated at the stern. These and other advantages are claimed. For the most part we can endorse them, but with regard to the fact that there is no obstruction to the movement of the boat when the propellers are out of action, we cannot speak from experience. We are informed that experiments have been made and that no difference either in speed or oil consumption could be detected over a measured distance with an idle propeller free to revolve or with the propeller removed.

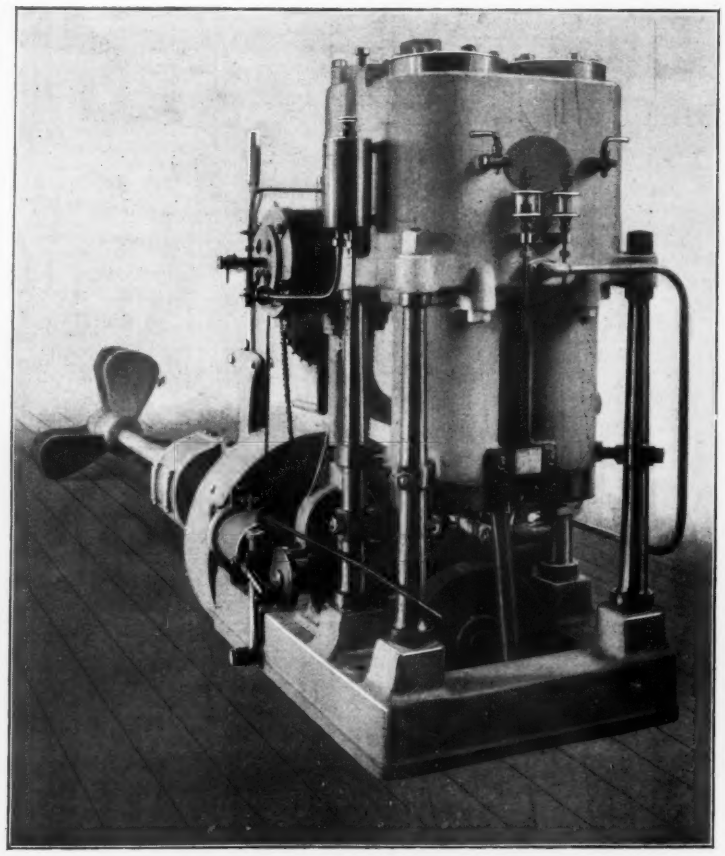


Fig. 1.—GRIFFIN LAUNCH OIL ENGINE

The launch is about 26ft. long on the water-line, and 6ft. 6in. beam, and she drew about 2ft. 9in. aft and 2ft. 3in. forward. The forward propeller is 24in. in diameter with a 3ft. pitch, and the aft propeller is 20in. in diameter and 3ft. pitch. They are placed one behind the other and are secured, the one to a solid shaft and the other to a hollow shaft in which the solid shaft revolves with an easy fit. A quantity of oil is pumped between the two, which serves the double purpose of making the running easy and of preventing any water coming into the boat, as might otherwise be the case. The manipulation of these two shafts will be discussed later on.

Fig. 1 of the illustrations is a reproduction from a photograph, and Fig. 2 is a sectional drawing of the engine. It is of the twin vertical type, and stands on four upright standards bolted to a cast iron bed. There is a rigid crosshead, to which are connected the pistons, and the slides are bolted to the cylinders, which, of course, are placed vertically. There is only one connecting-rod. The ordinary Otto cycle is used, and hence each cylinder gets an explosion every other revolution, and an impulse is given to the shaft every revolution. The cylinders are 5in. in diameter and 7½in. stroke, and the engine runs at about 260 revolutions a minute. Free and loose upon the engine shaft, and yet capable of being rigidly connected to it by means of a clutch, is a cast iron fly-wheel 20in. in diameter, weighing 2 cwt. The axle carries a pinion wheel which engages with another pinion wheel which performs two separate sets of operations. First it gears with another wheel which carries the governor. This is of the ball type, and it is horizontal, the balls being placed to point astern. Secondly, the pinion wheel is connected to a shaft which operates the air and water pumps, I and H, and actuates the inlet and exhaust valves of the engine by means of four cams keyed upon it. The bed-plate of the engine is cast as a chamber, into which air can be pumped. This is first of all done by hand till a pressure of from 8 lb. to 10 lb. on the square inch is obtained. When the engine is running the pressure is automatically maintained by the air pump. The compressed air is used to work a small oil pump which draws the oil from a tank placed in the bow of the boat and delivers it into a constant level reservoir fixed to the side of the engine, which is provided with an overflow. From the reservoir the oil is led to the vaporiser. Previous to starting this has been heated up by means of the sprayer, which is situated at one end. The spray from this on being ignited forms a powerful brush flame, which passes entirely through the interior of the vaporiser.

When the engine is running the cap F is, of course, screwed on, and the heating is accomplished by the exhaust gases. The vaporiser A, which is shown in section in Figs. 3 and 4, Fig. 4 being to an enlarged scale, is of the following construction:—It is cylindrical in shape, and is divided into three compartments. The first of these is a central opening running from end to end of the cylinder. This is provided with radiating fins or corrugations, so as to offer as much surface as possible. Into this the oil is sprayed through the sprayer B. Round it comes the second compartment E, which is annular in form, and through which the exhaust is made to circulate, entering through the passages E, and leaving by the opening E_2. Round this again, and also of annular form, comes the third compartment E, through which the air must come to be heated before it enters the cylinders. The air enters this compartment through D, and enters the cylinders through the passages and ports G. The oil is injected into the vaporiser in the form of a very fine spray. It is claimed that the change effected in the oil before it is burnt in the cylinder is physical simply and not chemical—that is to say, it is vaporised and not gasified—and that consequently the entire heating constituents of the oil are utilised and burnt. We saw one of the cylinder covers removed after—we were informed—three or four days' working. There was no sign whatever of any injurious deposit. The cylinders are self-lubricating, the slight film of oil, which is condensed on the walls, being quite sufficient for this purpose. From the vaporiser the oil vapour also is led to the cylinders, having been previously mixed, in the proper proportions, with the air. The actual starting of the engine is brought about as follows:—The loose fly-wheel, already mentioned, is revolved by hand by means of a hand wheel and link chain. When sufficient speed has been attained, the friction clutch, which, as has already been explained, can connect the fly-wheel to the engine shaft, is brought into play, with the result that the impetus of the fly-wheel carries the engine round, the explosive mixture is sucked into the cylinders, compressed and fired, and the engine starts and works by itself. Two pipes only lead to the cylinders, one to each. Each pipe, however, is provided with a diaphragm, which makes two pipes of it.

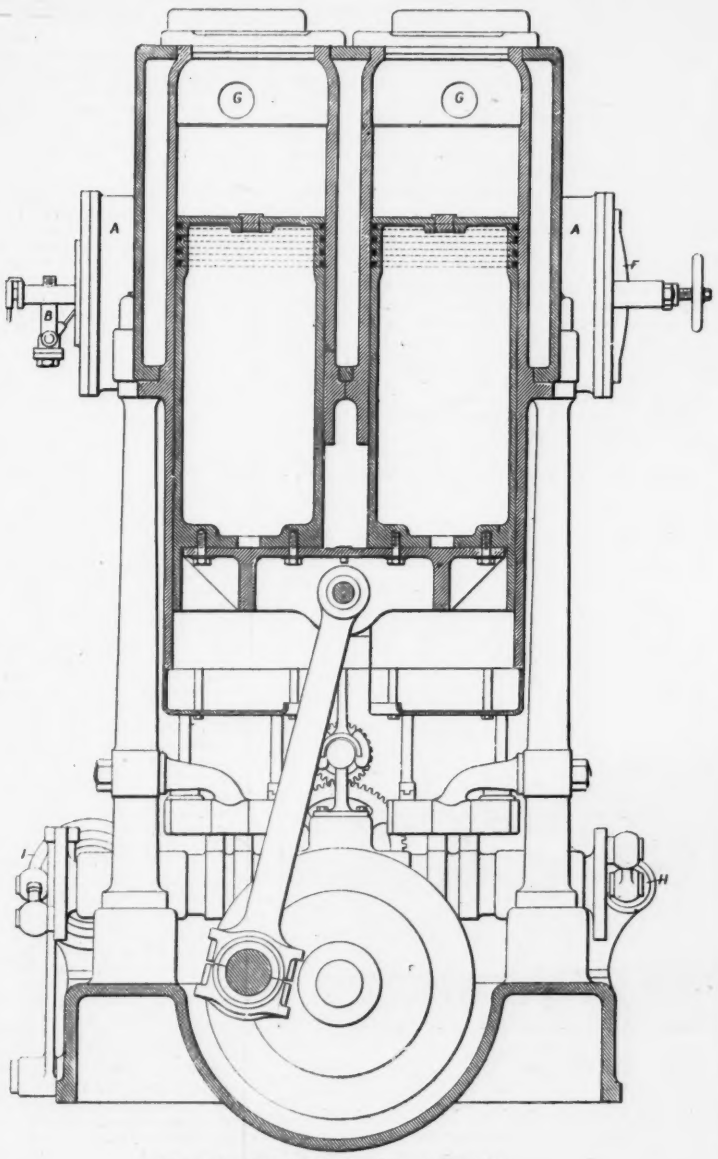


Fig. 2—GRIFFIN LAUNCH ENGINE—SECTION

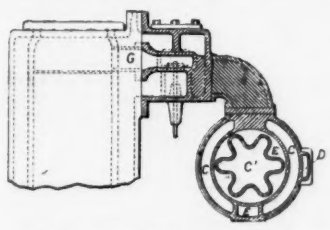


Fig. 3—VAPORISER—CROSS SECTION

Down one side of the division G comes the charge, and up the other side E goes the exhaust.

the explosive mixture to enter the cylinder. It is here where the action of the governor comes in. It governs the engine on the hit-and-miss principle. A small vertical lever is hung parallel with the valve spindle, and is attached to it by a connecting link. The lever when it is rocked to and fro can pull the valve spindle out of the upright and prevent its being hit by the striking piece. The governor rod is attached to this lever, and if the speed become too high the lever and the valve spindle are moved out of the perpendicular, the latter is not struck, no oil is forced into the sprayer, and hence no explosive gases go to the cylinders. The ignition jet is fed with oil from the main reservoir by means of compressed air from the air chamber in the bed. A very fine spray is formed, together with an induced current of atmospheric air. It burns with a blue flame precisely as an ordinary Bunsen burner. Difficulty used to be experienced in injecting a sufficiently minute quantity of oil, the absolute bulk of which is said to be about one-thousandth part the size of the flame produced, but this has all been got over. The speed is regulated by means of a spring on the governor spindle, which can be slackened or tightened by turning a thumb screw on the spindle. This can be done when the engine is

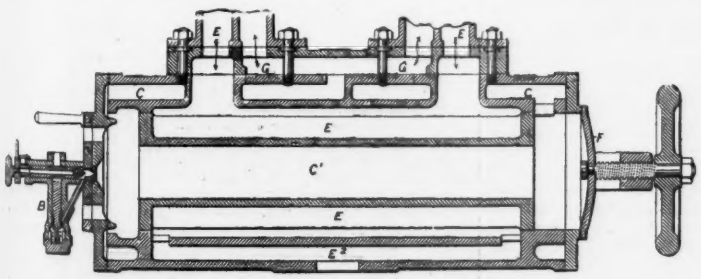


Fig. 4—VAPORISER—LONGITUDINAL SECTION

Mention has already been made of the shaft for actuating the inlet and exhaust valves, and to the cams which actually do this work. There are, in all, four cams. The shaft stands horizontally. The two cams on the outside regulate the exhaust valves—those on the inside, the inlet valves. On the inside cams bear wheels, which are carried by levers pivoted to arms bolted on to two of the uprights, supporting the cylinders. Each arm is provided with a hardened steel striking piece placed immediately under the long vertical spindle actuating the inlet valve. As the arms are rocked up and down by the revolution of the cams, this steel striking piece impinges on the valve rod, and forces it up against a spring, and opens the valve, causing

65 lb. to 70 lb. on the square inch, and we are told that the initial pressure is about 150 lb. on the square inch, whereas the compression is some 50 lb. on the square inch. Fig. 5 shows a reproduction of an indicator diagram taken from this engine. It shows a mean pressure of 70 lb. It has been found that when using a mixture of oil vapour and air alone the mixture is of too violently explosive a nature to be used successfully. An arrangement has, therefore, been made by which a portion of the exhaust can be mingled with the charge, thus allowing the particle of the explosive mixture to be separated to a certain extent from one another by a gas which is inert. The result is that the rate of explosion is decreased and brought within reasonable bounds. It was an interesting experiment to see this tried. The engine was running normally, that is, with some of the exhaust allowed to go into the cylinders with the charge. The pipe conveying this was then closed, and at once the explosions became irregular and violent, and the speed of the engine varied greatly. Ordinarily the speed was remarkably steady, and when properly started to work, one hardly saw the governor work and the explosions were timed with great regularity, the engine running smoothly and well. It must be remembered, too, that one of the propeller blades had been broken off, which did not give the engine a fair chance as regards steadiness of running. All that was felt was a very slight shake at each revolution, and very little noise, and evidently all that there was could be put down to the propeller and not to the engine.

The oil for running was, as has been said, carried in a tank in the bows. This tank was large enough, so we were informed, to carry a four days' supply under ordinary running conditions. At the time of the trial this tank contained a mixture of oils. There were "Royal Daylight," refined "Tea Rose," and "White Rose." This mixture was not, so it was said, necessary for the running of the engine. It had simply happened that fresh supplies had been put into the tank on two occasions when the tank was not empty. The

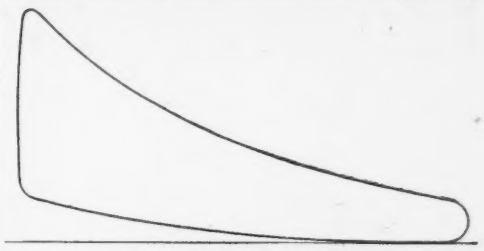


Fig. 5—INDICATOR DIAGRAM

kind of oil used, we were told, does not appear to matter. Anything can be used from a specific gravity of ·800 to ·820. With oil at 8d. a gallon it costs about ½d. per mile to drive the boat, which, under ordinary conditions, goes at the rate of about eight miles an hour. The weight of the engine complete, with shafts and propellers, is about 12 cwt.

Fig. 6 of the illustrations shows the mechanism by which the motion of the engine is communicated to the propellers. It consists of a double-friction clutch which can be worked by a hand lever. The clutch consists of a box E keyed on to the engine shaft F. The solid shaft B carrying the forward propellor is taken almost to the end of this box. The hollow shaft, B_1, carrying the after propellor, stops short at the mouth of the box. Each is furnished with a disc, which fits loosely into the box, but which, at the same time, is provided with a split ring, H and H_1, so that when either of these split rings is expanded by having a wedge driven into the slit, the effect is that the inside of the box is gripped, and the motion of the engine can be transmitted to either one of the propellers. To put the other propeller in gear it is only necessary to release the first ring and expand the other. The way this is brought about in actual practice can be readily seen from the drawing. A hand lever is connected to a sleeve Z which can slide on the engine shaft F. This sleeve is connected by the rod L to a yoke G, which slides on the surface D, inside the friction clutch box. By this means it is easy to grip whichever shaft is required, by pushing G into the slit in either H or H_1, or to disengage both, in which case the engine would run free without the propellers.

On the occasion of our trip on the Thames we had a very good opportunity of estimating the value of the engine, and of forming an opinion as to how it was likely to work in this connection. It seemed to us that as regarded the actual working there was little to be desired. The engine worked silently. There was no sound of explosion or of the exhaust when on board. It was only when one saw the launch moving away as one stood on a landing-stage that it was realised that there was any exhaust at all. There was very little smoke at any time. What there was mostly occurred just as the engine was started. When it had been running for some little time there was no appreciable smoke at all. The people in the launch itself, therefore, need not fear to be annoyed by either of these causes. In itself the engine is clean, and there was practically no smell. The governor gear answered well. The slightest tendency to increase of speed was at once checked, and by the very best means, namely, the non-admission of explosive mixture into the cylinder. There is no tampering with the relative proportions of gas and air. There is, in addition to the automatic governor, a mechanical means of preventing the gases from entering the cylinders. A

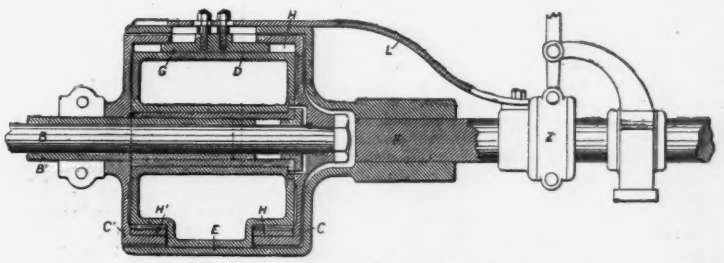


Fig. 6—REVERSING MECHANISM

running. It was done for us to see, but we should say that the operation requires considerable skill.

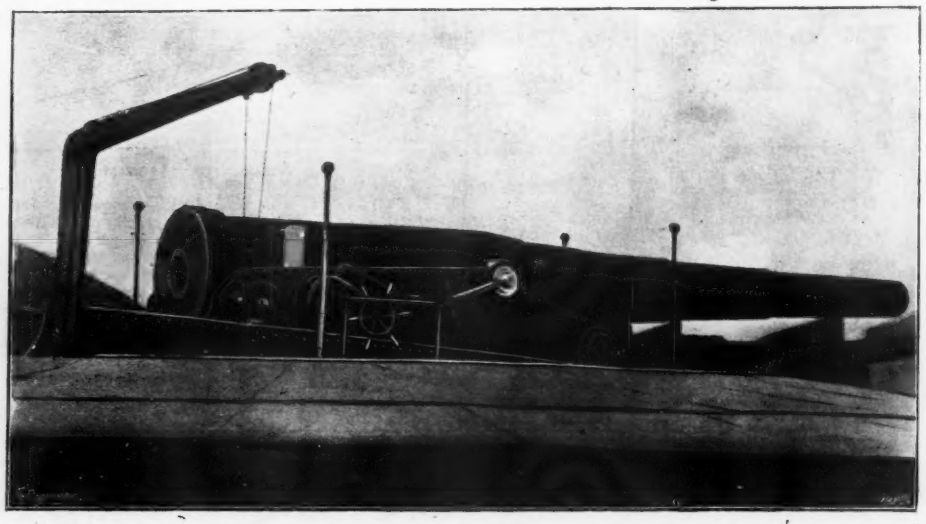
The mean pressure in the cylinders is stated to be from

system of levers actuated by a foot stop brings this about, and can be manipulated by the person steering. The admission of gas to the cylinders can be completely prevented by this.

INSTITUTION OF MECHANICAL ENGINEERS.

AT an ordinary meeting of the Institution of Mechanical Engineers on Friday evening last, Lord Charles Beresford delivered an address entitled "Openings for Mechanical Engineers in China." It will be found printed on page 547, and we discuss it elsewhere. In introducing the speaker, Sir William White, the President, said that the Institution had departed from its usual course in inviting a person who was not an engineer to give them a paper, but he thought that the conditions were exceptional, and that the members could not fail to hear much of interest and profit in the present case. Lord Charles Beresford then read the paper, interpolating as he proceeded not a few shrewd remarks and several amusing anecdotes. One or two of the latter we may be permitted to quote, as they show very graphically the state of the Chinaman's mind with regard to modern inventions, and indicate the importance of educating him first to some adequate apreciation of the value of human life, time, and money, before he can be led to see the advantages of modern ways and means.

On one occasion Lord Charles Beresford saw a large Krupp gun, to which an Armstrong breech had been attached with a display of considerable ingenuity, and in reply to inquiries he was informed that the original breech had been blown out. At another place he saw another of these guns, and asked to be shown the powder that was used in them. It was brought, and he expressed surprise that a rapidly burning powder should be used in such a piece, observing that the gun would surely be destroyed by it. The mandarin who accompanied him nodded, and said, "Yes, that is right; the breech was blown out when we tried it; several men were killed." "Then you have given up using that sort of powder now?" Lord Charles Beresford asked. "No," was the reply, "we



KRUPP GUN FITTED WITH ARMSTRONG BREECH

tried it in another gun. More men were killed." It was one of these guns that had been seen with the Armstrong breech attached.

We have applied to our Special Commissioner, who was in China in the early part of 1898, for further particulars of this accident. He has now sent us a photograph of the actual gun, showing how it was damaged. The reason why our Commissioner did not send us this photograph for illustrating his articles on "Modern China," was that he considered that the impression created by it might be misleading, and that it might be assumed that the accident was due to a defective gun. Now, however, that Lord Charles Beresford has publicly referred to the matter, there is no indiscretion in publishing this photograph, and we would take this opportunity of endorsing the verdict of Lord Charles Beresford, and of the mandarin with whom he conversed, to the effect that it was the wrong powder, and not defective material or workmanship, which caused the catastrophe, although the gun was "made in Germany."

As another example of the recklessness of the Chinese, he mentioned that in one fort he had found that a muzzle-loading gun had to be run back into the magazine itself to be loaded. He went over a big powder factory, fitted with splendid machinery almost quite new. He called the attention of the mandarin to the fact that the windows were open, and that if a little grit blew in and got between the steel rollers an accident would probably occur. "Yes," the mandarin replied; "you are quite right. It did blow up last year. This is the new building." At one of the forts there were a number of guns which appeared to have their front in a direction at right angles to that from which the enemy would be likely to attack. Lord Charles Beresford pointed this out, showing that only one gun could fire in the desired direction, down the river. He was told, "Oh, no, we train the guns so," and they were laid in echelon. Being given permission to fire them, he called the men away from the guns, and hung bits of clothing, &c., in their places. He then fired the gun furthest to the left, and showed that the clothes which held the position of "No. 4" at the next gun were blown to pieces by the blast, and so on with all the other guns. The only remark of the mandarin, on being shown this telling experiment, was, "Yes, some men would be killed, but the shot would hit the enemy." He gave these anecdotes as showing the absolute disregard of human life, and the absence of even preliminary precautions against accident.

The Chinaman's lack of business methods is almost as remarkable. His principle is to pay large dividends and never to put anything by for depreciation, repair, and replacement of stock. Thus it came about that all establishments which were entirely under Chinese management were utter failures. But the Chinaman was honest and upright in his business transactions, and his word was as good as his bond. It was true that many objectionable practices obtained in China, but it was the system and not individuals who were at fault. Mr. G. J. Morrison, who spoke at the conclusion of the address, referred also to this point. He believed that Chinamen were gentlemen, but they worked under conditions which rendered it impossible for them to be honest from a European point of view. For example, high officials received absurdly small salaries, and it was quite understood that they would increase them by the acceptance of bribes. "Now bribery is a method of collecting money which lends itself to abuse," but in other particulars the Chinaman could be relied on, and if he gave his word he would adhere to it, though to his own disadvantage. He went on to give some particulars of the difficulties of conducting business in China, and particularly of opening railways, of which he is the pioneer on that continent, because of the suspicion with which the Chinese regard the attempts of foreigners to make money in China. They cannot be persuaded out of the opinion that their country is to be robbed, and the more a scheme holds out prospects of financial success the more trouble will be found in getting it passed by the authorities. He thought Lord Charles Beresford had painted the opportunities for engineers in China in a too rosy light, and he advised young men not to go out there until they were in possession of some official guarantee that they would have employment, and not to accept posts and places hundreds of miles away from the protection of their country and their consul. Lord Charles Beresford signified his acquiescence with Mr. Morrison's remarks on several occasions during the speech. Mr. Griffiths and Mr. Goodwin then spoke, the former advocating the establishment of an exhibition of European machinery in China, and suggesting that it should be a floating exhibition, which could be carried from place to place. Mr. Goodwin laid some stress on the difficulties of conducting trade with China. The last speaker was Mr. Bainbridge. He agreed with the author of the paper, that the best means of awakening China was by the construction of railways, and he was of opinion that this country should stand as guarantors. The Chinese would then borrow English capital. He went on to speak of the objectionable likin tax and its bar to progress. He felt sure that if it could be stopped wages would be raised, poverty would be less, and the buying powers of the people would be increased. He considered that China was well worth the attention of English capitalists.

In replying to the various speakers, Lord Charles Beresford said he admitted the difficulties to which allusion had been made. It was certainly difficult at present to conduct business in China, but he still adhered to his opinion that chances there were, or rather would soon be, great for the mechanical engineer. China is going to be opened up. He spoke further of the natural honesty of the Chinese, but that their system prevented them from exercising it, and expressed his opinion that China was not overtaxed so much as badly taxed. He again insisted on the civilising and developing power of railways, and in reply to one of the speakers, defended Mr. Kinder's action in purchasing American locomotives instead of British engines. Mr. Kinder was bound in honour to do the best he could for his company, and the American engines were cheaper and could be delivered sooner, so that there was not only less outlay to begin with, but dividends were earned sooner. It was true that the American locomotives were not as good as the British, but that was not the point. The American engines were suited to the purpose for which they were required, and were therefore rightly purchased.

The difficulties of trading in China would soon be removed, the railways would dissolve them. The railway was the best argument to use against the likin tax, because the mandarins could not stop the trains to levy it.

After a few words from the President, proposing a vote of thanks to the author of the address, the meeting separated.

The attendance was remarkably large, the room being so full that seats for several members who arrived late were found on the platform.

THE GREAT NORTHERN RAILWAY.

NEW BRANCH LINE AND GOODS STATION AT LEEDS.

No. I. (*continued*).

IN our last impression the principal general features of the five-span viaduct on the skew at Middleton Colliery were illustrated in our page engraving, and sufficient information was, we trust, afforded to enable our readers to form a very fair idea of the design and type of construction. It remains now in our present article to describe and illustrate somewhat more in detail, and upon a larger scale, several of the chief points of interest connected with the building up or putting together of the different members and component parts constituting the entire structure.

It has been already remarked that the girders of the viaduct at Middleton Colliery belong to the Warren system, which was the prototype of the open web girder or truss, and still theoretically occupies that position, when treating of the stresses to which lattice girders, or those having two or more series of triangulations in the web, are subjected. A brief reference to this class of girders, which, it must be admitted, are not often seen now, although they did good suit and service in their time, and are still fully capable of performing the same duties as formerly, may not be out of place, nor devoid of interest. We may pass over the earliest stage of the Warren girder, when it was constructed of cast iron, with a perfect indifference, on the part of the designer, whether any member of it was exposed to a compressive or tensile stress. As might be expected, many accidents and failures occurred, some of which, it is to be regretted, were attended with a loss of life. It was these failures, accompanied by others belonging to different types of construction, which led, many years ago, to the appointment of the Commission to inquire into the application of cast and wrought iron to railway purposes.

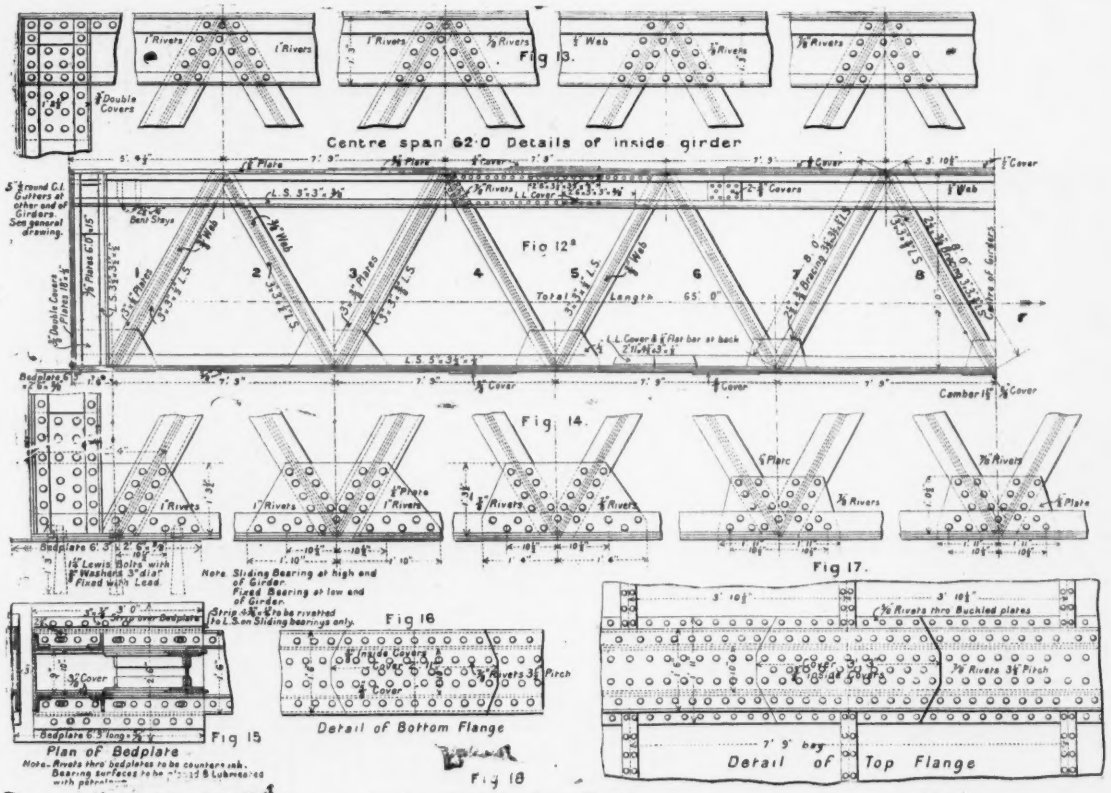
One of the distinguishing characteristics of the original Warren girder, in addition to its single equilateral triangulation in the web, was that pins were universally used instead of rivets to connect the diagonal bars and the flanges or chords. This system, in spans of 60ft., was very largely used for Indian bridges, and also for those in other foreign countries, partly under the plea that it was much easier to put the girders together with pins than with rivets. At that time, when skilled labour abroad was scarce, dear, and unreliable, the argument had a good deal of weight, but at the present it lacks nearly all its former force. One of the most remarkable Warren girders perhaps ever built is the Crumlin viaduct. It consists of several spans of 150ft., with a breadth of flange of only 9in. Some while ago the bars in the web, which were connected to the chords by pins, were solidly riveted up to the flanges. But it is only fair to state that the loading to which the bridge was subjected at the time of the substitution was very greatly in excess of what it was originally intended to carry.

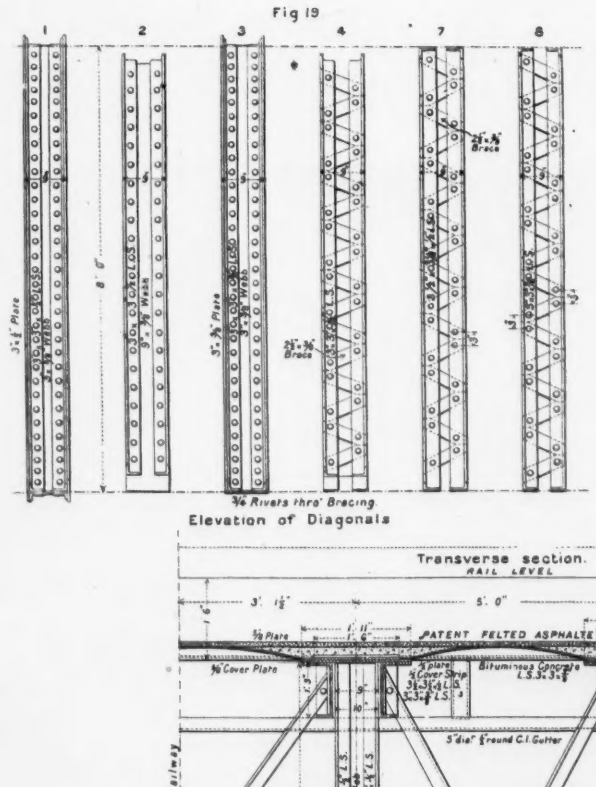
An elevation of one-half of the central girder of Middleton Colliery Viaduct, which has the maximum span of 62ft., is given in Fig. 12*a*. Both the flanges are of the trough form, but the upper flange has a pair of side vertical plates 1ft. 3in. in depth, which are not included in the lower flange, which is arranged differently, as shown in the transverse section in Fig. 21. The deep side plates in the upper flange enable the necessary rivet area to be readily obtained for the attachment of the diagonal bars of the web, and the required area in the lower flange is afforded partly by the increased vertical dimension given to the longitudinal steel irons, and partly by the gusset plates, which are shown to an enlarged scale in Fig. 14. Taking our illustrations in consecutive order, Fig. 15 is a plan of the bed-plates, which are specified to have the rivets countersunk and all bearing surfaces planed and lubricated with petroleum. The bearings at each end of the girders are, as is usual, not of quite the same pattern. Those at the high end of the girders are to be sliding bearings, that is, bearings upon sliding or rubbing plates, and at the low end fixed bearings. These last—shown in Fig. 14—are secured to the supports by Lewis bolts, 1¼in. in diameter, and washers 3in. in diameter by ⅜in. in thickness, run with lead. Details of the joints in the upper and lower flanges are given in Figs. 16 and 17, and an elevation to a distorted scale of the horizontal plates and angle steels will be found in Fig. 18, which give the lengths, reaching a maximum of 30ft., and the thickness of each. An elevation in a vertical plane of the diagonal bars, both ties and struts, is represented in Fig. 19, which indicates that all the ties in the web are counter-braced, and designed to do duty as struts or compressive members if they should be required to act in that capacity. Fig. 20 shows the cross section of the diagonal bars just described. In the transverse section, in Fig. 21, the diagonal bracing connecting the main girders, consisting of angle steels 3in. by 3in. by ⅜in., together with the angle steel brackets thrown out to support the parapet, or side-plate girder, are in elevation. The platform, or floor of the bridge, in the same figure, is carried up on buckled plates, and it is to enable these to be securely riveted to the upper flange that one of the horizontal plates is increased in width for 18in. to 25in. The haunches of the buckled plates are filled in to the level of the crown with bituminous concrete, and the whole flushed up with patent felted asphalt, turned up for a depth of 1ft. 6in., as a kind of ballast-board along the sides of the parapet girders. In the three following figures are represented the position of the girders on the bed-plates, a section of the bed-plates, and a cross section—Fig. 24—of the expansion joint over the bearings on the piers. A half elevation and half plan of the parapet or outside plate girder completes our description and our illustration of the valuable and instructive working drawings of the first important bridge on the new branch line at Leeds of the Great Northern Railway.

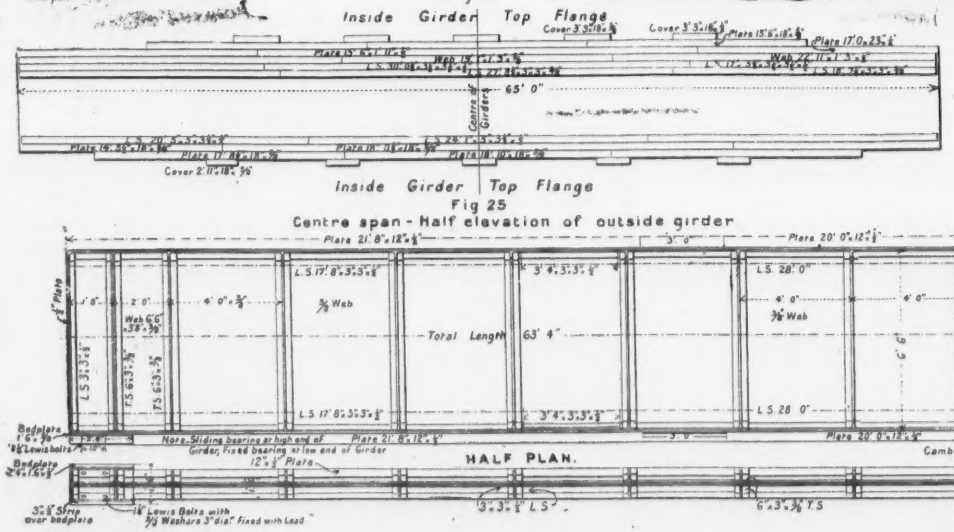
THE torpedo gunboat Sheldrake was commissioned at Sheerness last week after extensive refitting, including the substitution of water-tube boilers for her old ones, at a cost of £28,000. The Sheldrake will proceed to the East Coast of Scotland for fishery protection duties.

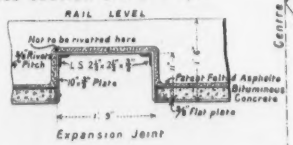
HUNSLET RAILWAY—VIADUCT AT MIDDLETON COLLIERY—DETAILS

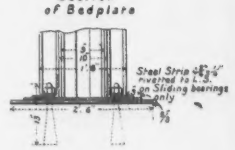
(For description see page 542)











THE RECENT DISASTER IN DARJEELING.

WE are indebted to a resident at Darjeeling for the following particulars, taken from a private letter, and the photographs on page 545.

Towards the end of September, Darjeeling, that picturesque health resort of Bengal, was visited by one of those extraordinary rain storms—30in. of rain in 36 hours—which, to a certain extent, are characteristic of that beautiful hill station; but on no former occasion have the results, both as regards loss of life and destruction of property, been so excessive. Situated as it is about 7000ft. up the Himalayas, Darjeeling extends for nearly a couple of miles along a mountain crest, reaching down 1000ft. on either side from the highest level of the hill. Below the town are tea gardens and other cultivation, on slopes running down in some cases to within 1000ft. of sea level. The European houses have, for the most part, been erected on sites cut out of the slope known as Observatory Hill. The steepest part of the slope faces the north-east, and it was amongst the houses built on this ridge that the greatest havoc was wrought.

In Darjeeling the rainfall averages 120in. per annum, but a daily fall of 10in. is no unusual occurrence. To realise what these figures represent, let it be assumed that an inch of rain fell universally throughout the United Kingdom on any one day, the aggregate fall would reach the almost incomprehensible total of over 7692 millions of tons of water. This being so, is it any wonder that a locality, where 30in. of rain fell in 36 hours, should suffer? The converse undoubtedly is the case, and the marvel is not that so much damage was done, but that the station was not entirely swept away.

Sunday, the 24th, the day of the catastrophe, broke cold and gloomy, with a steady downpour of rain, which appeared to increase in volume as the day advanced. By midnight a strong wind was blowing, and houses on exposed locations were in danger of being unroofed. At the time of the calamity, it was reported that an earthquake had occurred, but experts have now satisfied themselves that there was no seismic disturbance. With the dawn of Monday there was a cessation of wind and rain, but a dark, misty mass enshrouded the snowy peaks. Wild rumours soon gained currency, and when the people sallied forth, many who could not scramble over the yawning gulfs made by the landslips and boulders which blocked every road, had to return to their homes. Thus cut off from one another, with news more and more exaggerated as it was passed from mouth to mouth, the heart of all Darjeeling was filled with sorrow and dismay. When the roads had been partially cleared, and people could get about, it was found that the whole of the hill to the east of Chowrasta had been swept away, having carried with it most of the roads, broken down portions of three villas, and all the houses to the extreme left. The out-offices of Arcadia Girls' School were demolished, and here five servants perished. In Mall-villa six children were crushed to death; but although the greater portion of the Diocesan Girls' School buildings were seriously damaged, all the children and teachers escaped. A village of Bhutias, known locally as "Bhutia Bustee," was completely washed away in some parts, and nearly a score of villagers perished in the ruins. Most of the outhouses on the eastern side of the Mall were buried in the *débris* washed down the mountain side, and a considerable number of the natives were killed by this slip.

Devastation in varied forms met the eye at every turn, and the erstwhile peaceful town was thrown into a state bordering on panic. Strange to say, the death-roll amongst Europeans did not exceed ten, and these all children, but amongst the natives the mortality has been awful. Engulfed in the sliding hillside, when they ventured out from their houses, buried in their huts, which collapsed over their heads, and carried away in the roaring torrents which were soon formed in the valleys, death met them on all hands, and at the lowest estimate, 500 souls must have perished.

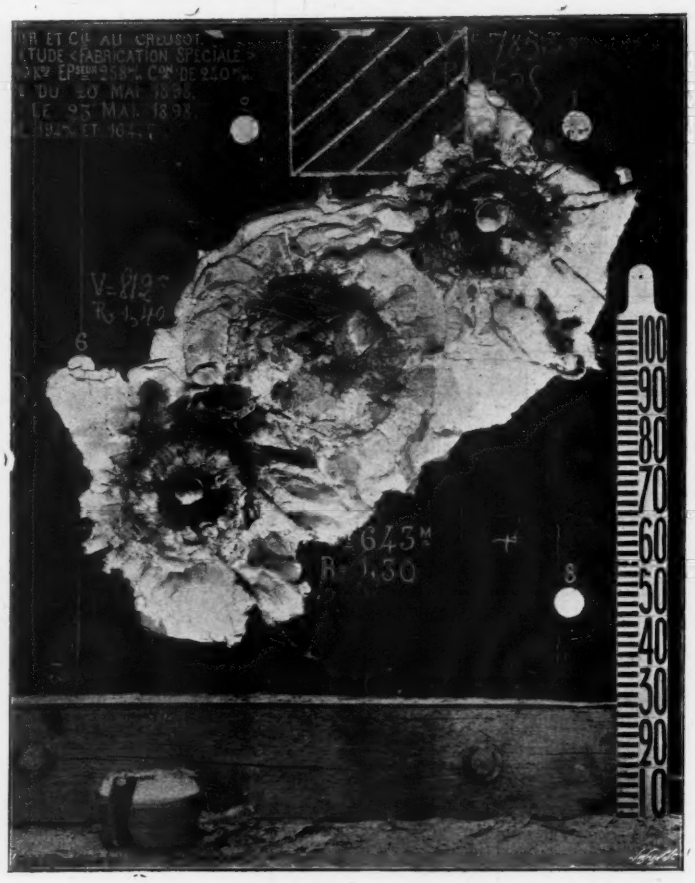
Over 300 officers and men of the Munster Fusiliers turned out and helped to clear away the *débris* and extricate the dead, while search parties, headed by the local clergy, worked strenuously in the common cause of humanity. Many instances of personal heroism and hairbreadth escapes are recounted; indeed, all who escaped scatheless appeared to disregard personal safety in their endeavours to assist their less fortunate neighbours. The funeral of the victims was a most impressive, albeit melancholy ceremony, and is unlikely ever to be forgotten by any of those who witnessed it. As the little white coffins of the European children were reverently placed side by side in the grave, a company of the deceased's school companions sung an appropriate hymn, and amidst the large concourse of people who attended the funeral, there was scarcely one who did not shed tears. Owing to the disorganisation of the electric light plant, the town for nights after the calamity was enveloped in darkness, and amongst the inhabitants a feeling akin to awe prevailed throughout the night watches. As the search parties proceeded with their gruesome task, ever and anon could be seen men, women, and children, cold and stiff, in the postures in which they were sleeping when overcome by the death-dealing avalanche. Altogether the spectacle, while terrifying in the extreme, was one calculated to touch the heart of even the most callous, and there is no resident, be he European or native, upon whose memory the awfulness of the catastrophe has not been indelibly stamped.

Outside Darjeeling the same woeful tale of dire destruction had to be told. What had once been a railway line and cart road was, after the landslip, a series of huge gaps between cavernous-looking hills, with the rails left suspended in the air. Viaducts and suspension bridges were swept off by the abnormally swollen mountain streams, while the railway at numerous points was completely blocked by enormous accumulations of *débris*. New watercourses were formed throughout the district, and the public roads and other thoroughfares were in many places entirely obliterated. Hundreds of acres of tea land and plantations have been destroyed, and the loss under this head is very considerable.

How to prevent the recurrence of such a calamity has been the question considered and discussed by many eminent engineers in Darjeeling, and the consensus of opinion seems to be that more capacious and stronger drains are primarily requisite. A deep and broad catch-water lade, securely pitched with granite, and covered with a strong iron grating, which, while supporting any ordinary fall of rocks, would still allow the water to be drained off, has been recommended by experts, and the general feeling is favourable to this project. To lessen the chances of future mishaps, it has also been suggested that all the small flats should be levelled off, and projecting boulders removed. The latter proposal doubtless carries a good deal of weight, especially when it is borne in mind that the recent calamity was in a great measure due to the fact of a number of boulders getting loose on, and rolling down Observatory Hill. The eyes of the authorities have also been opened to the great danger to which buildings erected on the eastern slope of this hill are subject, and precautions will, no doubt, be taken in future to prevent the erection of any houses on sites of questionable security.

SCHNEIDER HARD-FACED ARMOUR.

WE have received the result shown in the figure herewith, in answer to a request for information, from the Schneider Works, at Creusôt. The trial, it will be seen, took place last year. The result is remarkably good. The plate is 250 mm. (9·83in.) thick. It is termed a special cemented plate. It was attacked, first, by one round from a 24 cm. (9·45in.) gun, the projectile weighing 144 kilos. (317·5 lb.), striking with a velocity of 643 metres (2110 foot-seconds), and subsequently by two rounds from a 19·4 c.m. (7·64in.) gun, firing projectiles of the weight of 75 kilos. (165·3 lb.), with striking velocities of 785 and 812 metres (2576 and 2664 foot-seconds), which produced effects shown in the figure herewith. The first round has a calculated perforation of 21·3in.



250mm. SCHNEIDER ARMOUR PLATE

of wrought iron, or 2·16 times the actual thickness of the plate; the last two rounds, 23·1in. and 24·4in. of wrought iron, the last being 2·49 times the thickness of the plate. This is a tremendously severe attack. The plate has entirely defeated it, but has cracked in thin cracks. The plate appears to be rather harder and less tough than those made on the Krupp process. If the scale shows centimetres, the projectiles must have spread and set up considerably.

Special Hard-faced Schneider Plate.

Thickness of the plate		250 mm. (9·848in.)
Diameter of the projectiles:	1st shot	240 mm. (9·449in.)
"	2nd and 3rd shots	194 mm. (7·638in.)
Weight of the projectiles	(240 mm.)	144 kilos. (317·465 lb.)
"	(194 mm.)	75 kilos. (165·347 lb.)
Nature of the projectiles		Chrome steel
Striking velocity:	1st shot	643 m. (2110 f.s.)
"	2nd shot	785 m. (2576 f.s.)
"	3rd shot	812 m. (2664 f.s.)

Tested on the 20th and 23rd May, 1898.

HARBOURS AND WATERWAYS.

The Thames.—Attention has recently been called to the condition of the Thames for navigation by the shipping and mercantile papers, in consequence of a letter of remonstrance which was sent to the Thames Conservancy by the Atlantic Transport Company. It is contended that up to Tilbury Docks a channel giving 30ft. at any state of the tide ought to be provided, and that unless more extensive dredging operations are carried out than those now in progress or contemplated, trade will be driven from the Thames to rival ports on the other side of the Channel. The Thames Conservancy have only a limited income, regulated by an Act obtained in 1894; the amount available for dredging, derived from the dues levied, amounting to about £30,000 a year. The remainder of the dues are applied to harbour and moving services, removal of wrecks, and regulation of the navigation. The Commission which was appointed to inquire into the condition of the lower Thames, a few years ago, advised that the channel should be dredged to a minimum depth of 26ft. over a width of 1000ft., as far as Gravesend and Tilbury; from thence to Purfleet to a depth of 24ft. over the same width, and from there up to the Albert Docks to 22ft. over a width of 500ft. The first portion of the dredging has been completed, and there is now a minimum depth of 26ft. at low water of ordinary spring tides from the sea to Gravesend. From Gravesend the dredging is being continued, and a channel has been completed to a low-water depth of 24ft. up to Crayfordness, and 22ft. to Rainham Creek. It is contended by the Conservancy that to increase the depth of the Lower Reach to 30ft. would be utterly beyond the resources at their command, and that to raise the funds it would be necessary to treble the present tonnage dues on all the vessels frequenting the river, for the advantage of the few exceptionally large vessels that now navigate it. The total number of vessels that navigated the river last year was 43,343, and less than two per cent. of these were over 6000 tons; and there were only four vessels of between 5000 and 6000 tons net register, and only one vessel over 8000 tons. It was given as a reason by the Commission for fixing a depth of 26ft., that such a channel would be sufficient for nine-tenths of the shipping regularly entering the port of London; and that in the three years previous to their inquiry—1891-4—the total number of vessels entering the Thames, drawing over 26ft., was only 50, and of these 13 were telegraph vessels or warships.

The trade of the port has been continually growing, and has increased from nine million tons in 1864, about the time that the Thames Conservancy Board was first established, to twenty-five millions at the present time. The size of ships is also continually increasing, and unless the navigable facilities of the port of London also progress, and the same accommodation be given as at other ports, London cannot expect to retain its present position.

It seems rather anomalous for the authority responsible for the dredging and maintenance of the channels of the greatest port in the world to have to urge, as a reason for not keeping their works up to date, that they are not able to procure money enough for the purpose, while at the same time it is admitted by shipowners that London is less expensive than any other port in the matter of its charges.

This opportunity may be taken to call attention to the fact that the Conservancy is about to lose the able services of its secretary, Mr. Gough, who, after thirty-five years' service, is compelled to retire owing to ill-health.

The London and India Docks.—These docks are at present managed by a Joint Committee, and their earnings have been pooled since 1889, the London and St. Katherine's receiving 69 per cent. of the net profits, and the East and West India Company 31 per cent. Under this arrangement the average dividend paid by the former during the last ten years amounts to a little over 2 per cent., while in twelve years the shareholders of the latter have received only 3s. 4d. in dividend. The financial position of the companies is not due to any decrease in the tonnage, for this has increased from 905,280 tons in 1834 to 4,224,312 tons in 1898. The principal decrease in income has arisen from the effects of free trade, which has very greatly reduced the number of duty-paying articles which had to be stored in warehouses, and this formed the most profitable part of the dock business. A large number of new wharves and warehouses have been built, to which the goods are conveyed to and from the vessels in barges which pay no dock dues. One of the conditions attaching to the original Act of Parliament under which these docks were constructed was, that lighters and barges should be allowed to follow the water from the river into docks free of all charges. It is estimated that the loss to the companies occasioned by lighters amounted to £33,000 a year, besides a large proportion of the cost of the police, which amounts to upwards of £20,000 a year. The number of barges which entered these docks free of charge in 1898 amounted to 142,217, of an estimated tonnage of 9,000,000 tons. Sometimes 150 lighters have to be locked in or out at one entrance in a single tide. This involves the opening and closing of the gates near the time of low water, and the consequent admission of mud in suspension, which has to be dredged out.

It is now proposed, in a Bill which is to be promoted by the Joint Committee next session, to apply for power to levy a toll equal to 1s. 6d. per ton on all goods delivered or received overside into or from barges. This, it is expected, would restore the financial condition of the company, and, if not leading to actual prosperity, would at any rate stave off impending bankruptcy. In a very complete and able statement as to the condition of the two companies drawn up by the chairman of the India Dock Company, he states that the affairs of these docks have now reached a stage when if something is not done there must soon be a financial crisis, and that under present conditions it is impossible to provide docking facilities for the expanding trade of the port of London, the absence of which must bring ultimate disaster to the port. He contrasts the condition of Liverpool, Glasgow, and other ports with that of London. The Mersey Docks and Harbour Board have power to levy a toll on every ton of goods imported into or exported from their premises, so that the more business done the greater the profit. This toll has provided the funds for carrying out the immense works which have been found necessary to keep the port up to date. No such funds are available in the Port of London, and the profit made now is less than it was twenty-five years ago, although the capital spent has been nearly doubled.

THE LANDSLIP AT DARJEELING

IDA VILLA

ROADSIDE VILLA

KAG JHORA

TOONG 3OONG VILLAGE

SIDE OF No. 2 MALL VILLAS

ROAD ROUND OBSERVATORY HILL

RAILWAY MATTERS.

THE Uganda Railway has been opened as far as Nyrobi, 326 miles from Kilindini.

ON the 29th ult., M. Brand, the contractor and chief engineer of the Simplon Tunnel works, died at Berne.

ACCORDING to the *Times*, the Pennsylvania Railroad is acquiring the control of the Baltimore and Ohio line.

WE hear that the Sirdar has decided to open the Wady Halfa-Khartoum Railway on January 4th, 1900, from which date there will be a weekly service of trains.

THE Board of Trade have recently confirmed Orders authorising the construction of a light railway from Bradford to Leeds, and from Kelvedon to Coggeshall.

THE project for an electric railway from Croydon to Brighton, recently referred to in these columns, will not, it is now stated, be brought forward in the coming Parliamentary session.

IT is announced that the extension of the City and South London Electric Railway will be opened with new stations at London Bridge, the Bank, and Moorgate-street, early this month.

MR. JAMES STAATS FORBES having resigned the chairmanship of the Didcot, Newbury, and Southampton Railway, which he has held for many years, Mr. G. T. Harper, of Southampton, and Winchester, has been chosen to fill that position.

LAST week a beginning was made with the construction of the lines with which the Devonport Tramways Company propose to connect the town with its suburbs. By and bye, the Corporation of Devonport will commence the lines which are to supplement these in the company's scheme. Electric traction has been under consideration for some time.

AN amusing story comes from the Cape. The station-master at a junction on the way to De Aar was notified of a "goods train" arriving. It came, and disgorged not goods but armed Marines. Later on steamed up an armoured train with Bluejackets and two heavy guns, covered with a tarpaulin, and ironically labelled "Fruit."

TWO reasons have prevented the directors of the Simla-Kalka Railway from beginning the construction of this line. In the first place, the Government of India have insisted on the alteration of the gauge from 2ft. to 2ft. 6in., thus entailing extra expenditure. In the second place, the completion of survey of an alternative route is awaited before a start is made.

ARRANGEMENTS for the construction by a syndicate of an electric tramway from Whitefield to Eccles, connecting with the Manchester Ship Canal at Salford Docks, have now been practically approved by the various authorities interested. It will be available for goods as well as passengars, and will be over twelve miles in length. The cost of construction and equipment is estimated at nearly £120,000.

THE London and North-Western Railway Company owns more locomotives than any other company in the United Kingdom, namely 2436, or 1·18 engine to one mile of line. The Midland Company comes second with 2385 engines, or 1·51 engine to one mile of line. The North-Eastern Company has 2015 engines, or 1·26 engine per mile; the Great-Western owns 1909 engines, or 0·70 engine per mile.

ONE of the old Stockton and Darlington engine drivers, Mr. John Welsh, has just retired from the service of the North-Eastern Railway Company. Mr. Welsh entered the service of the old Stockton and Darlington Railway Company, at Harlepool, in 1853, and in the forty-six intervening years has travelled nearly two millions of miles on the footplate, during which time he has scarcely ever had an accident.

ON Monday at Burnley a town's meeting unanimously approved of the Corporation's proposal to promote a Bill for re-laying the Burnley and district tramway, which will come into their possession next year, for providing electrical equipment, and carrying branch lines into various parts of the town. It was stated that the probable cost of reconstructing the present line and making the extensions proposed would be about £150,000.

IT is estimated by competent engineers that there is at least £300,000 worth of railway carriages and wagons at present building in the Midland Counties for South Africa. These include a large number of long bogie wagons, carrying about 20 tons each, and of 3ft. 6in. gauge, for delivery at Southampton for Bechuanaland. They are the same patterns as those used in the Egyptian war. Another company is building railway carriages for Rhodesia. Large steel armour-plated hospital vans are building at a third works for the Cape Government Railway.

AMONG the interesting schemes for which sanction of Parliament is to be sought in the coming session is one for a railway tunnel under the Thames below Erith, the promoters of the Purfleet and Gravesend Junction Railway proposing to connect the London, Tilbury, and Southend and the South-Eastern systems with a line which, starting in the parish of Wennington from a junction with the former between Rainham and Purfleet stations, would pass under the Thames and join the North Kent line of the latter in the parish of Stone, between Dartford and Greenhithe stations.

A PROPOSITION is on foot to construct a combined road and railway bridge over the river Wear at Sunderland. It is to be the joint property of the Sunderland Corporation and the North-Eastern Railway Company. The length of line and bridge will be about 1½ miles. The bridge itself will have four spans—one of about 300ft., and three of about 190ft. each; and then there will be archways of the usual type afterwards. The railway will be borne on the top of the bridge, the roadway underneath. The cost of the railways and bridge may be roughly put as about £400,000.

THE Barry Railway Company has recently obtained from the Cooke Locomotive and Machine Company in the United States a tank engine having three pairs of coupled wheels. The same works have recently built and shipped two engines of a similar class, with four pairs of driving wheels connected, for the Port Talbot Railway and Docks Company. They weigh in working order 75 tons, with 61 tons on the driving wheels. The cylinders measure 19in. by 24in. and the driving wheels are 52in. in diameter. The engines will also have extended wagon top, crown bar, type of boilers with 219 tubes 2in. in diameter and 11ft. 11in. long, and a working steam pressure of 175 lb.

A MEETING of engine drivers and firemen employed on the Great Central Railway was held on Sunday last at Sheffield. For some time it appears that there has been some friction between the men and the company with regard to the hours of labour. The men demand a ten-hours day, and the company offer a sixty-hours week, which does not seem to be the same thing. Then there is a difficulty about mileage. It is recognised by the company that 150 miles is a fair daily mileage, but at the present time numbers of drivers and firemen are travelling as much as 220 miles a shift throughout the week. This extra mileage ought, in the men's opinion, to bring the driver 13s. a week extra pay, but the company only pays 6d. a day extra—3s. a week. Resolutions were passed asking for an interview with the directors, and failing the granting of this within ten days, placing the matter in the hands of the two railway societies, viz., the Associated Society and the Amalgamated Society of Railway Servants, and agreeing to abide by their instructions.

NOTES AND MEMORANDA.

THE world's loss of sailing vessels during the first half of this year amounted to 92 ships, of 51,191 tons; of this number the United Kingdom supplied 10, of 9109 tons.

THE Norddeutscher Lloyd steamship Kaiser Wilhelm der Grosse, the fastest liner in the world, has agsin broken her own record, having made the run from Cherbourg to Sandy Hook in five days sixteen hours.

THE total quantity of iron ore raised last year was 70,000,000 tons, which would give 36,507,500 tons of pig iron. This quantity of iron, it is estimated, would form a belt round the earth at the equator 2ft. wide and 7¼in. thick.

THE metal used in the casting of bells is an alloy of copper, in the proportion of four parts of copper to one of tin. The copper is first melted and the tin added just before pouring. One of the secrets in bell-founding is to have the molten alloy heated to the critical point exactly.

ACCORDING to the returns recently published by Lloyd's Register, the number of steam vessels for the whole world totally lost, condemned &c., during the half-year ended June last was 51, of a net gross tonnage respectively of 43,203 and 67,553. The United Kingdom's loss amounted to 14 vessels, of 15,679 net tons, and 25,215 gross tons.

A BERLIN firm is responsible for the novel application of the flexible shaft. In a small pleasure boat the power generated by a naphtha engine is communicated to the propeller by means of a flexible shaft which passes through a curved steel tube, leading over the stern of the boat. This curved tube, besides carrying the propeller at its end, is also fitted with a rudder, and is moved by a tiller. The whole apparatus, it is said, can be quickly fitted to any small pleasure boat.

THE Trans-Pacific cable survey, now being conducted by the United States Government between Honolulu and the Philippines, by way of Midway Island and Guam, reports that two offsets are necessary owing to obstacles encountered. One of these is a submarine mountain rising 13,200ft. above the floor of the ocean, and coming to within 82 fathoms of the surface. The second obstacle is one of the deepest submarine valleys or clefts yet found in the world; soundings show a depth of 29,400ft. below the ocean surface.

A PROCESS is now being exploited in the United States for the manufacture of buttons from milk. After being skimmed in separators the milk is boiled until it assumes a sticky mass, which, after being kneaded, is placed into linen sacks, and deprived of all moisture by the use of a heavy press. The remaining matter is then taken out of the sacks, placed in a specially prepared drying apparatus and subjected to heat by means of steam pipes. After two or three days this matter grows yellow like gold and becomes hard like a stone. The remainder of the process is at present a secret.

AN article appeared some time ago in a leading German electrical paper by Mr. B. L. Montel on high-efficiency electric incandescent lamps. The author states that, to obtain the maximum economy, the lamp should be replaced after 250 to 300 hours only of its life, although it would last much longer before burning out. The cost of the new lamps necessary reduces the apparent economy of high-efficiency lamps to from 30 to 60 per cent. of what it would be if the life were as long as that of low-efficiency lamps. The drop of candle power of high-efficiency lamps is also much greater than with those of lower efficiency.

THE Holland submarine boat was tested recently at Greenport by the Board of Survey and Inspection of the U.S. Navy Department. The test was made in water 20ft. deep. The run of one measured mile, submerged 10ft. below the surface, was made in nine minutes; the Holland then rose, discharged a Whitehead torpedo, and disappeared in ten seconds. The torpedo weighed 840 lb., and was discharged from the bow tube, and at a range of 400ft. it passed within 25ft. of the target flag; the torpedo had no war-head, and travelled 800ft. The Holland then turned under water in one and a-half times her own length of 54ft.

THE Metropolitan Street Railway Company's power station in New York, when complete, will exceed the maximum output of the Lucania's engine-room by over 100 per cent. It will include eleven cross-compound engines of 6600 maximum horse-power. The preliminary design for the power house of the Manhattan Elevated Railways provides for eight huge four-cylinder compound engines, each capable of developing 10,000 indicated horse-power. Two of the cylinders will be carried vertically above the crank shaft on the usual A frames, and the other two will be placed horizontally, all four cylinders working upon a common shaft.

IT is stated that the power houses which are either being planned or built for the three largest railway systems in New York, when completed, will each greatly exceed any other aggregation of motive power in the world. The first of these to be completed will be the central station of the Metropolitan Street Railway Company, with a total capacity of 70,000-horse power, and following this will be an 80,000-horse power station for the electrical operation of the system of the Manhattan Elevated Railways, and an even larger station, with a reported maximum capacity of 100,000-horse power, for operating the electric roads of the Third Avenue Railway Company.

AN extraordinary phenomenon is said to have been noticed in connection with the chestnut trees in the Avenue Louise, Brussels, since the electric tram service has been in use. The foliage of the trees begins to turn brown and drop early in August, to bud, and even to blossom again in October. The trees on the opposite side of the tramway behave like ordinary trees, for they lose their foliage in the late autumn, and do not put forth fresh blossoms until the spring. Botanists are inclined to believe that the cause of this singular state of things is due to the electrical current which passes underground acting upon the roots of the trees, which are otherwise quite healthy.

A PAPER was presented at the Boston meeting of the American Association for the Advancement of Science on electric power from windmills, by Mr. C. L. Crandall. The author gives estimates of the lamp-hours per day produced by a ⅔-kilowatt dynamo, and a 12ft. aërmotor. The paper showed the relation, found by experiment, between the B.H.P. of the mill and the wind velocity, when the speed is adjusted for maximum efficiency, and various other data. The wind velocities were averaged from the records of the anemometers of the State Weather Bureau at Ithaca, and it was found that the 12ft. motor would provide a minimum of 19 lamp-hours—16 c.p.—per day, while a 16ft. aërmotor would give 35 lamp-hours, under the conditions assumed.

IN connection with the transmission of current of high potential the Union Carbide Company of Niagara Falls, the current is stepped down from 11,000 volts to 2200 volts at the works by means of seven transformers each of 2500-horse power capacity. These transformers are double the size of the largest hitherto constructed. The total weight of each unit is twenty-two tons, of which one-half is made up by the sheet iron used in the core. The clamps for holding the latter together weigh nearly two tons. The enclosing case is about 11ft. high and 8¼ft. by 4½ft. in plan. The transformers are immersed in oil, which is cooled by water circulating through 650ft. of piping. The energy in the form of heat which must be disposed of in this way amounts to over 40-horse power at full load.

MISCELLANEA.

A branch of the Automobile Club of Great Britain and Ireland has been formed in Manchester.

IN Chicago the post-office authorities are about to try motor vehicles for service between the head office and sub-stations.

THE abolition by the Russian Government of the import duty on agricultural implements has not affected the influx of machinery of this class into the Caucasus, at any rate not through Batoum.

THE royalty collected to November 1st on the output of gold in the Yukon district this year amounts to 730,689 dols. It is estimated that the output for next year will be double that for the present year.

DRIVERS of steam motor vehicles in Washington, U.S.A., will in future be required to pass an examination, and take out a licence to drive. All boilers as used are also to be periodically inspected by the proper authorities.

A NEW sewerage system for San Francisco has been recommended by a board of engineers. The proposed plan includes a comprehensive sewerage system for the city and county, based on a future population of 1,000,000.

THE new City Subway which has for some time been in progress below the street level at the busy crossing between the Mansion House, the Bank of England, and the Royal Exchange, is rapidly approaching completion, and will shortly be open to the public.

THE Sheffield Corporation have applied to the Local Government Board for sanction to borrow £100,000 for the purpose of the municipal electric lighting scheme, and an inquiry was conducted by a Local Government Board inspector on Monday last in Sheffield.

AN extraordinary accident occurred at the National Harbour Works, Dover, last week. A 20-ton travelling crane on the end of Admiralty Pier extension suddenly fell from the works into the sea. The engine driver had a very narrow escape, but he managed to jump clear and was only slightly injured.

THE experiments with patent fuel in the Surly torpedo boat destroyer, at Portsmouth have been concluded. The trials with oil were not successful owing to the density of the smoke, but more than twenty different kinds of briquettes were tried, and some of the samples gave very satisfactory results.

THE Hamburg-American Company announce that their express steamers will shortly call at Plymouth in connection with the service which is maintained between New York, Cherbourg, and Hamburg, and that in February the service to North Europe will be resumed, Plymouth being the English port of call instead of Southampton. The service will be a weekly one.

NICLAUSSE boilers of a total of 60,000-horse power, are under construction by the Stirling Co., Chicago, for the following United States war vessels:—Monitor Connecticut, building at the shipyard of the Bath Ironworks, Bath, Me.; United States battleship Maine, Russian battleship Retvizan, and Russian cruiser Variag, building at the works of the Wm. Cramp and Sons Company, Philadelphia.

ON Monday last, a suspension foot-bridge was opened at Abereyron, South Wales, by the Rev. J. F. Williams, J.P. The bridge is erected over the Taff Vale River, has a clear span of 160ft. by 5ft. wide, and was designed and supplied by Mr. Louis Harper, A.M.I.C.E., of Aberdeen, who, we understand, has also supplied another of these bridges recently for erection over the River Dove, near Uttoxeter.

IT was decided last week to postpone the departure of the new Royal yacht Victoria and Albert from Pembroke Dock for a month in order that the contracting engineers may be given sufficient time to thoroughly prepare the propelling machinery for the preliminary steam trials. Under the new arrangement, the ship will be undocked on January 6th. On the completion of the trials, she will proceed to Portsmouth to be prepared for service.

THAT eminently peaceful implement, the plough, is now to be put to warlike uses. At Aldershot Colonel Templer has been experimenting with a steam plough, made by Fowlers, of Leeds, for cutting trenches, which is reported to have given remarkable results. It threw up a 4ft. intrenchment at the rate of three miles an hour, over rocky ground. Two of these machines are being sent out with the South African Field Force. The machine is so arranged that it will erect works to right or left, and the picks in front of the ploughshares are so powerful that rocks and stones are split to pieces and thrown up.

THE Tyneside Electric Power Co., Ltd., referred to last week, is promoting a Bill in Parliament next session, empowering it to supply electric energy throughout the whole manufacturing district on both sides of the Tyne, from Blaydon and Newburn on the west to Tynemouth and South Shields on the east. The company proposes to generate electric energy on a very large scale, and to supply it both in bulk to local authorities for distribution, and also for motive-power purposes to works, shipyards, and manufactories. Among the directors of the Tyneside Company are the Hon. C. A. Parsons, F.R.S., and Mr. A. A. Campbell Swinton.

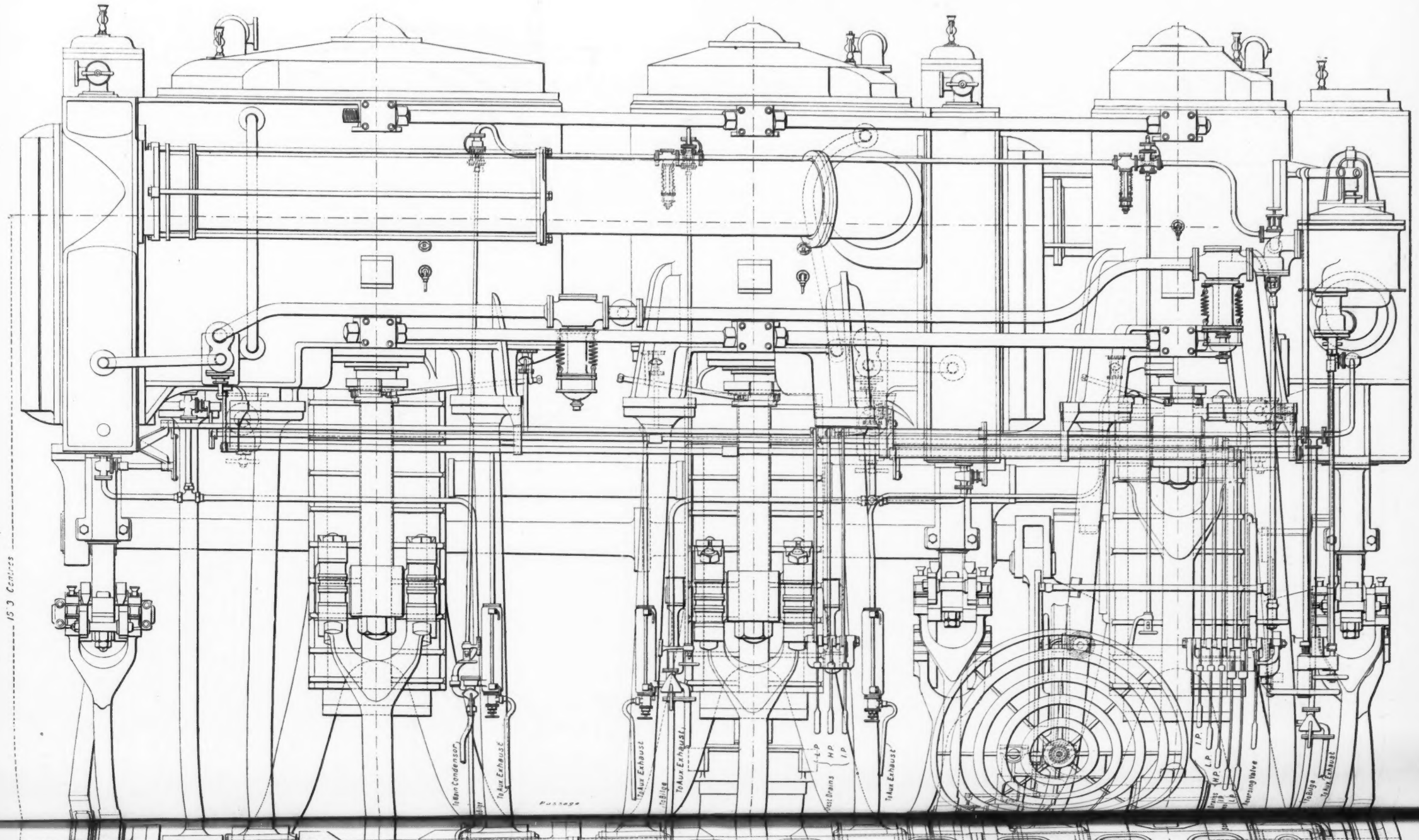
THE death is announced at Longfield, Kent, of Mr. John Prosser Allen, R.N., in his 73rd year. Mr. Allen entered the Royal Navy as an assistant engineer so long ago as January, 1847, becoming an engineer in 1855, and chief engineer in 1864, and retired in 1877 with the rank of inspector of machinery. According to the *Times*, he served in the Black Sea during the Crimean war and in the Azoff expedition, receiving the Crimean and Turkish medals, with the Azoff and Sevastopol clasps. He was landed with the Naval Brigade during the New Zealand war, 1863-64, and for his services on that occasion was awarded the New Zealand medal.

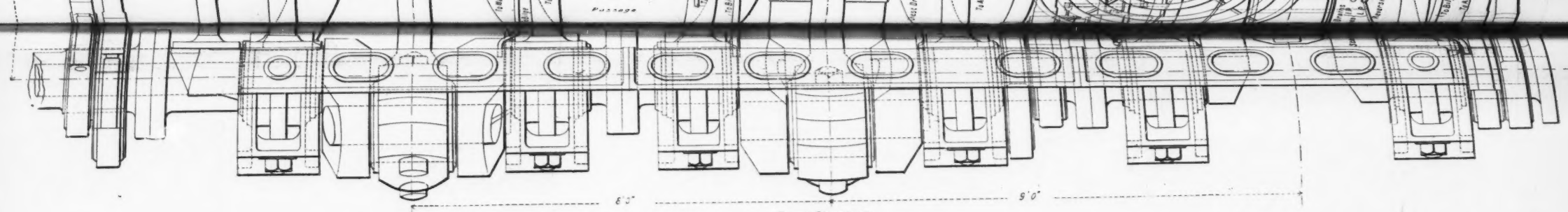
THE pneumatic postal-tube service in New York includes one conduit connecting the General Post-office with Brooklyn, and the others lead to the Produce Exchange; to Madison-square; to Station D, at Bowery and Sixth-street; and to Station H, at Lexington Ave. and Forty-fourth-street. The latter line is employed for all mails going out from the Grand Central Station, and is the most used. It is estimated that 800,000 letters are sent daily through this conduit. They pass over a distance of 3¼ miles in seven minutes, using about 2000 "carriers" per day. These carriers are steel tubes, 28in. long by 6in. diameter, and hold about 300 letters each, or any package less than 6in. diameter.

THE Barton Locks of the Manchester Ship Canal one day last week were the scene of a serious accident owing to the steamship Starlight belonging to the Stott line colliding with the lower lock gate, which was sent to the bottom of the basin. Fortunately the lock master had the presence of mind to immediately close the upper gate or the result would have been alarming. Between Barton and Mode Wheel, a distance of about three and a-half miles, the water is held up 15ft. above the level of the stretch between the locks of Barton and Irlam, a distance of between two and three miles. If the top gates had not been closed promptly the water from the upper section would have raced down till a common level was reached, and the damage done would have been very extensive indeed. This is the second accident of this nature which has occurred on the canal, the first having taken place at Latchford some time ago.

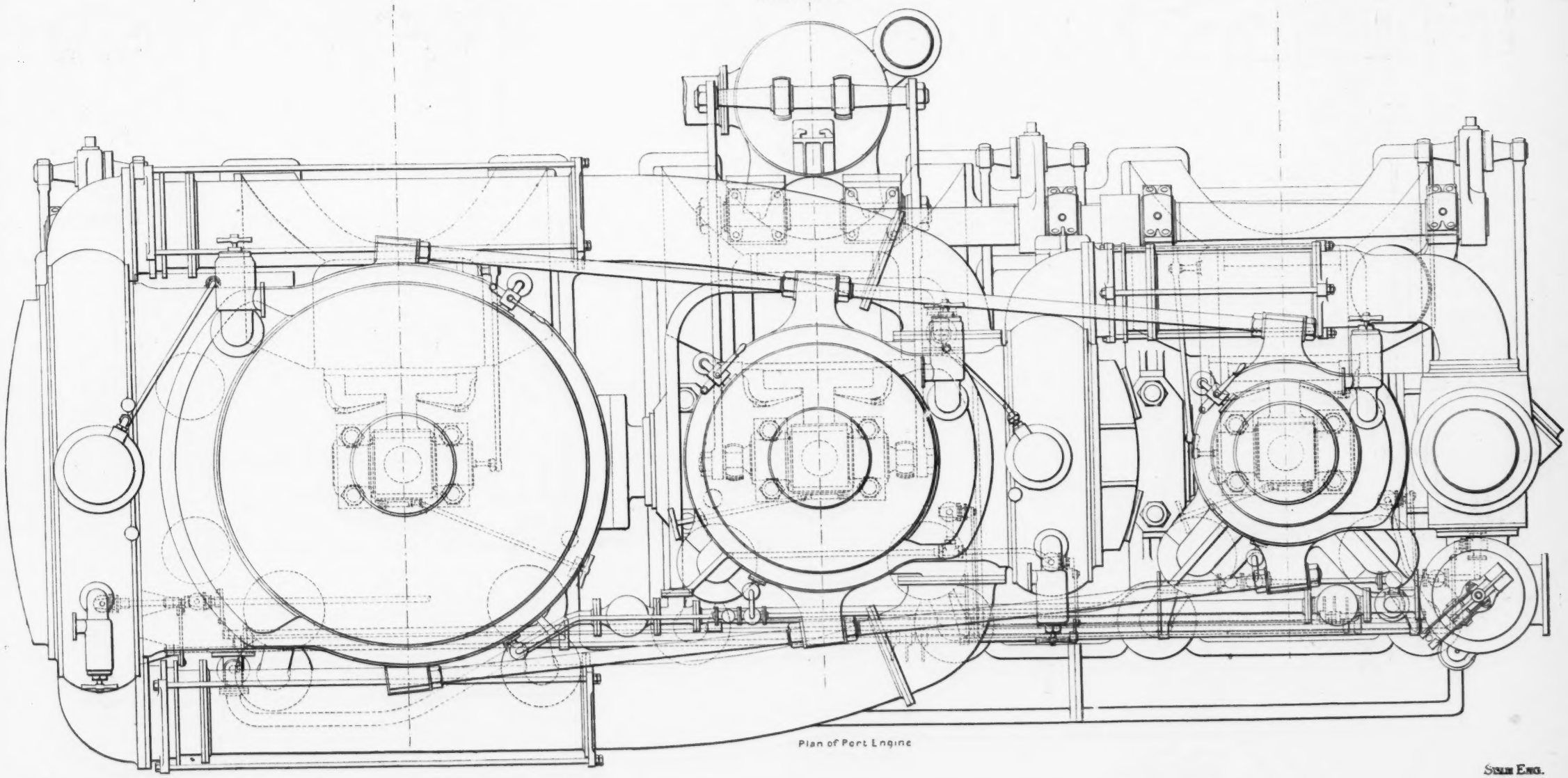
TRIPLE-EXPANSION ENGINES OF H.M.S. OCEAN

R. AND W. HAWTHORN, LESLIE AND CO., LIMITED, NEWCASTLE-UPON-TYNE, ENGINEERS





Front Elevation



Plan of Port Engine

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A complete set of THE ENGINEER can be had on application.

In consequence of the reduction of postage on newspapers to one uniform rate for any destination outside the United Kingdom, Foreign Subscriptions will, until further notice, be received at the rates given below. Foreign Subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post-office Order must be made payable to THE ENGINEER, and accompanied by letter of advice to the Publisher.

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Prices for Displayed Advertisements in "ordinary" and "special" positions will be sent on application.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Engraving of the Engines of H.M.S. Ocean. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TWO-PAGE SUPPLEMENT—TRIPLE-EXPANSION ENGINES OF H.M.S. OCEAN.

TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

F. P. (Burton-on-Trent).—We do not know what particular text-book is in favour with the examiners; but we think you cannot have a better book than Thearle's "Shipbuilding."

C. F. F. (Ripley, near Derby).—"The Experts Report on the Treatment of Manchester Sewage" is published by Henry Blacklock and Co., Limited, Albert-square, Manchester, and its price is 5s.

J. H. T. (London).—A good deal of the machinery used in needle manufactories is of special design, and the names of the makers are not given, but we believe that Manlove, Alliott, and Co., Nottingham, have had experience in this class of work.

S. AND MCL.—We do not know of any composition that would help you under the circumstances. It might be worth while to try putting a ring below the joint and pulling it up against the end with several bolts, so as to keep the composition in.

H. E. M. (Stamford).—As to books, you will find "La Fonderie," by Leverrier, published by Gauthier, Paris, price 3 francs, useful. Also see "The Cupola Furnace," by Edward Kirk, published by Spon, price 14s. You do not give sufficient data to enable us to say where your cupola is in fault. At first sight it would seem that you have not got blast enough.

T. C. A. (Glasgow).—We know of no recent book that would help you much. The matter is generally kept fairly quiet. Descriptions of various torpedoes will be found in journals and papers read before the learned societies—see the American Naval Institute "Proceedings" last year, and the *Genie Civil*, March 26th, 1898. A good number of dirigible torpedoes have been tried, but we do not know that any one has met with success. The chances of hitting vary so greatly with the conditions that no definite estimate can be given. Under well-known and fixed conditions at practice the misses, providing no accident takes place, are but few.

A. E. D.—Dr. Angus Smith's method of coating cast iron pipes to prevent corrosion is as follows:—The pipes having been thoroughly cleaned from mould, sand, and rust, are heated to about 700 deg. Fah. They are then dipped vertically into a mixture consisting of coal-tar pitch, about 5 to 6 per cent. of linseed oil, and sometimes a little resin, heated to about 300 deg. Fah. After remaining in the mixture several minutes, long enough to acquire the temperature of 300 deg. Fah., the pipes are gradually withdrawn and allowed to cool in a vertical position. Perfect adhesion should take place between the coating and the pipe, and the former should be free from blisters of any kind. In practice the heating of the pipes before immersion is found to be very expensive, and is frequently omitted. However, many engineers consider it essential for really good work.

MEETINGS NEXT WEEK.

ROYAL INSTITUTION OF GREAT BRITAIN.—Monday, December 4th, at 5 p.m., General Monthly Meeting.

RÖNTGEN SOCIETY.—Thursday, December 7th, at 8 p.m., at 20, Hanover-square. Paper, "Observations on Practical X-ray Work, with Exhibition of Apparatus and Stereoscopic Skiagrams," by Mr. Mackenzie Davidson, M.B.

HULL AND DISTRICT INSTITUTION OF ENGINEERS AND NAVAL ARCHITECTS.—Monday, December 4th, at 8 p.m., at the Parochial Offices, Bond-street. Paper, "Some Notes on Auxiliary Feed and Air Pumps, &c.," by Mr. J. Brackenbury.

SOCIETY OF ENGINEERS.—Monday, December 4th, at 7.30 p.m., at the Royal United Service Institution, Whitehall. Paper, "Water Supply to Country Mansions and Estates," by Mr. Gordon Harris, Assoc. M. Inst. C.E., M.I. Mech. E.

SOCIETY OF ARTS.—Monday, December 4th, at 8 p.m. Cantor Lectures. Four Lectures on "Enamelling upon Metals," by Mr. Henry Hardinge Cunynghame. Lecture III.: The method of making enamels—Fluxes—The metallic oxides.—Wednesday, December 6th, at 8 p.m., Ordinary Meeting. Paper, "Artificial Silk," by Mr. Joseph Cash.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 7th, at 8 p.m., at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. Adjourned discussion on "The Cost of Steam Raising," by Mr. John Holliday, Assoc. M. Inst. C.E.; "Influence of Cheap Fuels on the Cost of Electrical Energy," by Mr. R. E. Crompton, Past-President.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 5th, at 8 p.m. Paper to be discussed, "The Waterloo and City Railway and its Electrical Equipment," by Mr. Dalrymple-Hay and Mr. Jenkin. Paper to be read, "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc. M. Inst. C.E.—Friday, December 8th, at 2.30 p.m., Students' Visit to the Works of the Baker-street—Waterloo Railway, in course of construction.

THE ENGINEER.

DECEMBER 1, 1899.

LORD CHARLES BERESFORD ON ENGINEERING IN CHINA.

THE members of the Institution of Mechanical Engineers are to be congratulated on securing Lord Charles Beresford as the lecturer at their opening meeting last Friday. Lord Charles is not an engineer, he is not a great authority on trade, and he is a very random speaker. These facts would seem to suggest that he might not be the right man to address the members of a highly technical society on a subject which may be considered as theirs rather than his. There are, however, other qualifications than technical knowledge which occasionally make it desirable for an individual outsider to address our engineering institutions on their own territory, and these qualifications Lord Charles Beresford possesses in this particular instance. He is an active and well-known man, a member of Parliament, and one who is always before the public; he has recently paid a visit to China, with a view of casting a hurried glance over commercial methods in that country; has come home and written a book on the subject; and while he is rather given to generalising, as must be the case with the superficial student, he is a quick and sometimes an accurate impressionist. He is always candid, and he speaks with conviction.

The subject chosen, "Openings for Mechanical Engineers in China," was one of vital interest to his audience. The paper was divided into three sections:—(1) Railways, and Electrical Engineering; (2) Mining, and Allied Works; (3) Manufactures. The burden of Lord Charles Beresford's argument was to the effect that China offers an enormous field for engineering and commerce, but that we in England must bestir ourselves, and begin to look after our interests, or the Americans, Germans, and Japanese, will cut the ground from under our feet. Most of this is very true and to the point, and the value of the paper lies rather in the fact that it shows us that one in Lord Charles Beresford's position has thoroughly grasped the fact that England must look to her laurels in the Far East, and should be prepared to preach the doctrine, than that he should express it to this particular body of engineers, who were probably well aware of the truth of his contention. It is not the British engineer who must exert himself, and capture the work that China may or may not have to give out; it is for our politicians to protect our industrial interests in China, and thereby bring about the demand for engineering employment, which cannot be created until such time as Western financial and commercial people shall feel that they are secure in embarking in big industrial enterprises. When that time comes we shall find that English engineers, civil and mechanical, will be ready and willing to take appointments in China. As a preparatory step towards equipping themselves for such work, Lord Charles urged his hearers to study Chinese, by establishing an engineering school in Hongkong. This step has, he tells us, already been taken by the Americans and Germans. This advice, too, is sound enough in the abstract, but whatever the Americans and Germans may be doing—though one may say in passing, that Hongkong is not the proper place to organise a school of mechanical engineering for Europeans—it is hardly to be expected that British mechanical engineers in any large numbers will care to devote the necessary years of their lives to gain a knowledge of the Chinese language, in the vague hope that some day the British Government will wake up to a recognition of its duties and responsibilities in the Far East. Lord Charles tells us that within the next few years over 6000 miles of railways ought to be built in China. Precisely so; 6000 miles ought to be built—ought most certainly to have been built already—would equally certainly have been built had it not been for Great Britain's apathy. There is, however, no sign at present to indicate that our policy in China will be strengthened or modified in any way. Under these circumstances the time has not yet come for us to expect our engineers to take the risk of going to China on the chance of future employment, or for parents to send out their sons to learn engineering in the Far East where the facilities are vastly inferior to those available at home.

Lord Charles was unduly optimistic about the immediate prospects for British engineers in China, for under existing conditions the openings are few and far between. British railway engineers will not be wanted until railways are being actually built under adequate British protection; mining engineers will not be required until mine owners can venture to embark their capital in the interior in a way that will enable them to exploit their mines; and machinery agents will be grievously disappointed should they go out with a view of selling large quantities of tools for which there is no market. On the prospects of engineers Lord Charles Beresford talks with the optimism of one who cannot be aware of all the conditions which surround the law of supply and demand in the employment of engineers, and the soundest advice he gave to the Mechanical Engineers on Friday was that those who think of going out should consult Mr. C. W. Kinder, the British engineer of the Chinese Government railways, who has had greater experience of Chinese methods with regard to railway building than any European living. His lordship might have added that those who want accurate information as to the prospects of railway enterprise in China should address themselves to Mr. Gabriel James Morrison, who is now in England, and in that he has persistently championed the cause of railways in China from the first days when, more than a quarter of a century ago, he built the first and ill-fated line between Shanghai and Woosung, is the greatest available authority on the practical possibilities of railway extension. Our impression is that both Mr. Kinder and Mr. Morrison would tell engineering candidates for employment in China that, under existing political conditions, their chances are very nearly nil, and that on no account should they proceed to that country in the hope of finding a billet when they get there. All that Lord Charles said on the subject of China's enormous and undeveloped natural resources was true enough and to the point, and we cordially agree with him as to the necessity for England to take measures to protect us against continental and American competition; but these measures must begin by the British Government adopting a strong Chinese policy, and then the rest will look after itself. We have no statesman, no politician who has made Far Eastern politics his "line," and if Lord Charles Beresford is to develop into that much-needed political champion of our rights in the Far East, we see no reason why he should not become a most useful advocate of British interests. Let him take over or take up China as Mr. Henniker-Heaton has taken up postal reforms, and let him hammer and hammer away at our Government until he makes an impression. He has made the beginning of a praiseworthy but very difficult study which has entirely baffled our home politicians of the present day, and we feel sure that if he follows it up seriously a great deal of good may result, and under these circumstances we have no wish to cavil at certain technical inaccuracies and undue optimism in his lecture, for we are glad that he has undertaken to champion the cause of the Englishman in China, and we hope that he will continue to do so.

ECONOMICAL HAULAGE.

WE publish this week two letters, and an article from a United States contributor which are full of information and of no small interest. To Mr. Acworth we hasten to make our excuses for assuming that he went so far as to believe that railway companies in this country could haul as cheaply as those in the United States. He holds, indeed, that our management is full of defects; but he has not gone quite so far as seems to be pretty generally believed. The principal interest, however, in his letter is supplied by the very definite statements which he

makes concerning the actual cost of working heavy traffic in the United States. When we read these we no longer wonder that he admits that in this country we cannot carry coal or ore or grain at the extremely low rates ruling in America. It will be seen that in the article on page 547 very similar statements are made. A ton can be carried for about one farthing one mile. Mr. Twinberrow's letter is a supplement to Mr. Acworth's. With all the data before us, we cannot help saying that we want more. The information furnished us is incomplete. Railway men in this country will want to know how it is done. Thus, to take one example; in our last impression we gave particulars of yet another monster locomotive with no less than 87 square feet of grate—a grate some 11ft. long by 10ft. wide. It is designed, we are told, to burn a very poor fuel. According to Mr. Acworth we may take it for granted that one fireman will keep his grate covered with smudge coal. We ask ourselves what manner of man this must be, and how many hours a day he works? We can also imagine the spirit in which an English fireman would receive a proposal to go and do likewise. Again, when Mr. Acworth tells us that coal can be had on the Wabash road for 65 cents, or 2s. 8½d. a ton, and on the Chesapeake and Ohio for 54 cents, or 2s. 3d., we want to know whether this is the price on the tender, or at the mines, which is a very different matter; also what its quality may be. It is, we hope, within the bounds of possibility that our correspondents can supply more precise information. Meanwhile we may proceed to consider a little in detail what we have before us.

Let us take the fact that coal, ore, and corn can be carried at a profit for one farthing per ton per mile, and ask what this means. Are we to assume that the fractional sum named is sufficient to cover all expenses of every kind, or is it only the bare cost of haulage? In the country traders grumble at the rates charged by the railway companies, but these rates have to pay for much more than the fuel, oil, wages, and depreciation of plant expended in hauling a train a mile. We all know how heavy has been the fighting about terminals. If a ton can be hauled a mile for a farthing in the United States, is it certain that it cannot be hauled for the same price in this country? Are the huge engines, the 50-ton trucks, and the enormous trains essential to the attainment of that end; or are we to think that there are two ways in which the cost of haulage may be stated, and that the way used in the United States differs from the way used in this country? The matter is of special importance as regards grain. That is the only commodity reaching this country with which for the moment we are concerned. What about terminals? We want information as to how this grain is collected from vast areas of country, and sent to the railway station, and then loaded into the cars. We know all about the use of elevators on rivers, and their employment for discharging into steamers. But it is obvious that whereas the work of exporting grain continuously tends to concentration at the sea-board end of the line, the work of collecting it must extend over a very wide area at the country—or shall we say Western States' end of the line. This collecting work is closely akin to what we have to do here. We have numbers of short hauls. The railway companies have to collect comparatively small quantities of corn or coal or general goods, and transmit them to our great towns. In this country the work of the railway ends there. Our goods trains are made up of a truck from one town, two from another, and so on. Even our coal trains will be found with the trucks of three or four collieries in each. But in the United States the collecting business is but half the work. When 2500 tons or so have been got together, a long haul begins, and it is this long haul that is done at the fractional price. We have no conditions in this country which imply the necessity for anything of the kind, and even if we had, it is admitted by Mr. Acworth, as we understand him, that we could not expect to work at American rates. To sum up our demands, we say that we want some information on matters which have never been made public in the United States press, much less in the technical press of this country. We want to know how the enormous quantities of grain, for example, are collected at one terminus, in a way to keep several monster locomotives working twenty hours a day. To put this matter in a clearer light, we would ask our readers to bear in mind that an acre will not grow more than half a ton of wheat. Thus an area of not less than 5000 acres must be cleared to load one of these enormous trains. How is the collecting done, and at what cost? In a word, what is the position in the United States of what is known as the question of terminal charges as compared with terminal charges in this coutry?

Turning now to Mr. Acworth's figures, and criticisms of ours, and first as regards the cost of 10-ton coal wagons, we believe that we are right in saying that at least one large railway company in England has built them for a net cost of £40 to £45 each. They were common wagons, without spring buffers. At this moment it is not, we learn, possible to place an order with a wagon-building company at less than £70 each for wagons with buffers, and perhaps the price might be even greater than this. The point is, however, of moderate importance, and we are quite willing that Mr. Acworth should have all the benefit of it. His estimate of the mileage of an American locomotive is more interesting than the question of the price of wagons. It may, we think, be admitted that the life of an engine can be expressed in miles. An engine making 30,000 miles a year would be worn out in twenty years. That is to say, 600,000 miles would represent its life. There is, of course, the story of the Scotchman's knife, which was the same after it had had two new handles and five new blades; but we venture to say that Mr. Acworth will admit that 600,000 miles is a very good duty. If, now, the engine makes 60,000 miles a year it will last but ten years. We made an allowance for depreciation on the basis of 30,000 miles. We must double the allowance for 60,000 miles; and we ought to do much more than double it, because when an engine is worked twenty hours a day all the year round, so to speak, very little time is available for anything like a thorough repair. Indeed, it is only fair to say that many American engineers contend that if a locomotive lasts ten years it has lasted long enough. That it ought then to be sent to the scrap heap, and its place taken by something more modern, better, and more powerful. We have been laughed at for the excellence of our workmanship, and for building "for ever," instead of using up and buying more and much better. We do not say that such a policy is wrong, but we do say that if it is adopted a very considerable sum must be put on one side for depreciation, under any system of sound finance. Mr. Acworth minimises this difficulty by reducing the capital cost of the engine. He tells us that the price of an engine and tender, representing in running order 161 tons, or say, empty, 130 tons, was probably not more than 14,000 dollars, or £2800. We gave the probable price at £5000. We have taken the trouble to make inquiries since Mr. Acworth wrote to us in this country, and the answers we have received are eminently suggestive. They are tantamount to saying that such an engine as that on the Illinois Central Railway could not be built to the specification of an English railway company for less than £5000, but that if those who ordered the engine would be content to have it built in accordance with American ideas, something less than £3000 would be accepted at this side of the Atlantic. "It all depends on the specification." Here we may leave the question of price. Only we must not forget that the smaller the first cost the greater, in all likelihood, will be the wear and tear and depreciation. In fact, all such figures as those we have quoted from the *Engineering News* the week before last must be accepted with hesitation; they may or may not represent the facts. Some items may be too large, others may be too small. All that seems to be definitely known is that, as stated in our article on English and American Railways, certain classes of traffic can be conducted at one-fourth of a penny per ton per mile, or £2 12s. 1d. per mile for a train weighing 2500 tons net.

One or two mechanical questions deserve consideration for a moment. The first of these is the need for the enormous boiler with which the monster locomotive is fitted. At ten miles an hour on the level the resistance of a train is probably not much more than 6 lb. per ton, or for a train whose total weight is, about 3300 tons, say 20,000 lb. in round numbers. This, at ten miles an hour, represents but 533-horse power on the tender drawbar, and probably about 750 indicated horse-power. But the boiler ought to be able to work up to at least 2000-horse power, which would be competent to deal with very heavy grades, and we understand that it is because of these inclines the boiler is so large. But, on the other hand, it must not be forgotten that such an engine will not burn less than 3 lb. of coal per indicated horse-power per hour. If it be the dirty coal of Illinois, as seems to be the case, judging from the price named by Mr. Acworth, double that quantity would not suffice. But taking it that the coal is fairly good, we have for an average power of 1500 horses indicated an hourly consumption of 4500 lb., or, per mile, 450 lb., instead of the 300 lb. named in our first article. Now 450 lb. is as nearly as possible one-fifth of an English ton, costing, says Mr. Acworth, one dollar. This gives us just 20 cents per mile for coal alone. It will be seen that after all this bears a very small proportion to the whole cost. Even if it were doubled it would represent less than one-thirtieth of the entire sum paid for haulage. From this it may be gathered that the advantage derived from economy in fuel due to the employment of large engines must be extremely minute. This circumstance, of course, in no way affects our expression of doubt that 8d. per train mile really represents the actual expenditure. The statements, on the one hand, that the cost of fuel is something less than 11d. per train mile, while the receipts are as much as £2 12s. 1d. at one farthing per mile ton, which barely pays, shows how far we are from having complete information as to the expense of working heavy traffic in the United States.

It will be seen how easy it is in this way to arrive at almost any figures we please. As the matter is presented to us at present at this side of the water, the most that can be taken as certain is, that on United States railways very heavy trains are hauled at extremely low rates over considerable distances. It has been found generally that the larger the trains and the bigger the engines the less is the cost of transport. The case is quite analogous to the use of very large cargo steamers, which are cheaper to work than smaller vessels. But before conviction can be so far carried to the mind of the British railway director, information will have to be supplied which is not less accurate than that now available, and much more complete. We may add that we doubt very much that the railway men of the United States know, with any precision, what the net cost of haulage *per se* really is. They can prove generally that a small profit is made on big hauls at very low rates, and a loss on small hauls; and that is about all. It seems to be understood that the publication of precise figures is to be deprecated, and the proceedings of most of the American technical societies dealing with railway matters bear testimony to a very healthy diversity of opinion on most questions discussed.

ELECTRICAL AUXILIARIES ON SHIPS OF WAR.

The report of the chief of the Bureau of Steam Engineering of the United States lies before us. A large section of it is devoted to electrically-driven auxiliaries, and is practically an indictment of electricity for that purpose. It opens with the following passages:—

"For some time past—in fact, ever since the successful use of electric motors for general power purposes on shore—the bureau has been carefully investigating their adaptability to the driving of the numerous auxiliary engines on board ship, and, in view of the conclusion that the electric drive of the auxiliaries would not, under existing conditions, be so satisfactory and economical, on the whole, as the steam drive, believes it would be of interest to state the reasons for this conclusion. This is the more appropriate because in some quarters the fact that electric motors are extensively used on shore has led to the belief that they would be equally successful on board ship. The bureau has planned to use electric motors exclusively in its new plant at the Brooklyn navy yard, and it will be readily appreciated, therefore, that their non-use on board ship is for very good reasons."

Rear-Admiral Melville, the writer, then goes on to give the reasons which have led him so strongly to condemn the use of electricity. He shows that the weight of the plant is greater, that it is more delicate, that it cannot be readily adapted to the various conditions of service, that it is not nearly so economical as its advocates assert, and that it occupies space which might be more usefully employed for stowing coal. In short, he deals the hardest blow at electricity for naval work that it has ever received. Thus it comes about that the only navy in the world which has given an extensive trial to electrical transmission has found it wanting, and that those who have condemned the English Admiralty for not adopting that system in haste have received their answer.

We confess that Rear-Admiral Melville's report gives us no little satisfaction. We have consistently contended that the advantages claimed for electricity had never been proved, whilst its disadvantages were sufficiently patent to everyone but the electrical engineer. But we have always listened with patience to the arguments in its favour, and watched its trial with interest. The case for it has never been more strongly put than it was in these columns only a few months ago by an American engineer. We may fairly claim, therefore, that we have regarded the matter without prejudice. But, satisfactory as we find it to have our own views confirmed, it is as nothing as compared to the pleasure with which we find that the British Admiralty was right in not adopting, in deference to the opinion of some energetic critics, an untried system. It shows again how true is the observation that if our Navy is slow, it is very sure, and we may rest satisfied that when the time comes and electrical ship equipment has been so far improved that the numerous objections to it no longer obtain, the vessels of her Majesty's Navy will be among the first in the world to be fitted with it, and on a more complete and thorough scale than those of any other nation. It may be of interest to look into Rear-Admiral Melville's report a little more closely. We have already indicated the main heads of his objections. One of these is the weight of the electrical plant. Now if there is one point more than another in this subject to which the electrical engineer has devoted attention it is this. He has shown by data and figures that, taken all in all, and power for power, electrical energy can be applied for less weight than steam—on paper. But the Chief of the Bureau is not concerned with paper ships. The proof of the pudding is in the eating, and from practical experience he is able to assert that the electrical equipment is heavier than steam equipment, and occupies a greater space. He shows that if the battleship Alabama were fitted throughout with electric auxiliaries the total weight of machinery would be increased from 150 to 250 tons as a minimum, or as much as was gained by the adoption of the water-tube boiler. "Increased space occupied by the larger generating rooms would accommodate 900 tons of coal, or 3600-horse power could be added to the power of the propelling engines, giving the ship in the first instance 45 per cent. greater coal endurance, or in the second instance 1·5 knots increase in speed." He admits that these figures for space are excessive, but they are based on the present practice. But the advocate of the use of electrical transmission argues that the auxiliaries are never all in use at the same time, and that the generating plant need not be of the large size on which Rear-Admiral Melville bases his figures. To this the naval officer's answer is absolutely clear and decisive. Naval machinery must be designed so that in time of action everything can be ready for use at a moment's notice, and all, or practically all, simultaneously. This is distinctly a point on which knowledge of the conditions is the strongest argument against electrical transmission.

"I think," writes the author in another place, and his words may be weighed by the amateur naval critic in all countries, "I may be pardoned for saying that those who are most insistent on the electric drive are not at all conversant with the conditions obtaining on board ship, while those of us who have spent a lifetime in the care and design of naval machinery may fairly claim that we know something about what is needed." Electrical engineers are always able to show very plausible arguments demonstrating the superior economy of electric ship plants. These are, as a rule, based on the excessive consumption of steam in small auxiliary engines, and the small consumption which is claimed for high-speed compound electric generating sets. The author of the report emphatically denies that such economy exists, and goes on to show that the unequal conditions under which naval machinery must of necessity work is inimical to the realisation of such economy. In this case, again, the conditions which hold for the use of motors on land do not apply. The demand from auxiliary engines on ships of war is intermittent and irregular in amount, a very large range of speed and power is required, and under such conditions existing motors cannot be worked economically.

Another point which is frequently made much of by the electrician is the ease with which power can be conducted from place to place, and the absence of heat. But as Rear-Admiral Melville points out, the conditions on a steamship are again quite different to those on shore. There is no question of leading power to long distances. The auxiliary engines are, with few exceptions, close to the steam supply—closer, indeed, than dynamos can, as a rule, be situated, so that more piping is required to conduct steam to the generating engines than to take it direct to

the auxiliaries. It is to be remarked also that the most objectionable steam pipes in a vessel are those that run to the steering engines. Now electricians not infrequently condemn motors for that purpose as not sufficiently trustworthy. In the following passage from the report the whole matter is admirably summed up:—"The fact is that within what are ordinarily called the 'machinery compartments of the ship' the leading of the necessary steam and exhaust pipes for auxiliaries does not interfere with anybody's comfort nor does it raise the temperature unduly, and the distances are so short as to make the lead of piping very easy. Steam auxiliaries answer admirably the demands which come upon them at all speeds within their capacity, and the only possible objection which can be urged against them is that the simple forms usually employed for reliability are not so economical as the more elaborate ones which can be used elsewhere. They are far superior to electric motors on the score of adaptation to the service to be performed, and also far better for naval use on the score of weight. On the score of economy we have shown above that the claims ordinarily made for the electric drive are not tenable, except under special conditions, and it is further to be said for the steam-driven auxiliaries that at the times when economy is of the greatest importance when making long sea trips only a small part of the total auxiliary capacity is used, so that even if the saving by the use of electricity was what is claimed by the most enthusiastic electrical agents, the aggregate amount of fuel saved would be comparatively insignificant, and considerably less than the reduction in bunker capacity necessarily incident in a ship of a given size to the use of the electric drive." For the present it would appear, then, that electricity is not to take that place in the American navy which some people had hoped. That a time may come when it will be advantageous to use it no one will care to deny, least of all ourselves. That it has many attractive qualifications we are willing to admit, but we think with the shrewd author of this report that they may be purchased at too high a price.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the Institution of Civil Engineers on Tuesday night, and again before a crowded meeting, the discussion of the two papers in connection with the Waterloo and City Railway was continued. It was a decidedly more interesting and representative debate than that which we listened to last week. The speeches were well above the average, though there were some exceptions, and we were treated to some comments and accounts of actual experience from engineers who had themselves carried out similar tunnelling work and had the subject at their fingers' ends. These gentlemen, at all events, added usefully to the "Transactions" of the Institution. Mr. Francis Fox always speaks well. He made no exception on Tuesday. He put in his plea for the adequate ventilation of tunnel headings during construction. One almost expected he would. Ventilation is, of course, a hobby of Mr. Fox's. He was particularly emphatic, too, about Sunday labour, saying that engineers should set their faces against it, not allowing any save in cases where it is absolutely necessary. We entirely agree with him—"save in cases where it is absolutely necessary." One speech there was which sounded suspiciously like an organised "puff" of some thing American. It was interesting, though, so let it pass; especially as later speakers, while acknowledging its usefulness in some cases, demonstrated its inadmissibility in others—notably the deep underground railways of London. Perhaps the most interesting speech of the evening was that of Dr. Kennedy, though it was long, and it looked almost as though he had been requested to speak out time. He just failed, but only left five minutes for the last speaker. Many of those who took part in the discussion "had been to America this year." Every one goes there now-a-days. Perhaps it is the climate! Anyhow Dr. Kennedy had been. Some things he liked, some he did not. Among those he did not like were the American engines. They are four times as large as they need be—that is to say, they occupy four times the space. We certainly shall never see American engines in any of Dr. Kennedy's power-houses—to borrow an American expression. He himself says that his Scots ideas of economy forbid it. Speaking of some tests of the line which had come out differently to what was expected, he remarked: "Sometimes one has to take facts as one finds them." Surely one is not to infer from this that "facts" are ever represented as being what they are not—by engineers, at all events! The discussion was not finished, and will be continued next Tuesday.

THE Clyde Trustees have arranged with Sir William Arrol and Co., of Dalmarnock Ironworks, for that firm to scheme and execute a thorough reconstruction and renovation of large portions of the riverside quay walls, which have either collapsed or are giving indications of doing so. The work will involve the sinking of a large number of cylinders, in the manner so well carried out in the preparation of the foundations for the Forth Bridge and for the Jamaica-street and other bridges over the Clyde. The amount involved in this contract, we understand, approaches £20,000. The practice of giving undertakings out to contract will also, it is understood, be followed in the case of the new Clydebank dock. The Trust's engineering department has now the working drawings well in hand, and on an early date private contractors will likely be called upon to tender for the construction of the dock from the plans and specifications, as prepared by Mr. Deas and his staff.

BALLOONS IN SOUTH AFRICA.

THE question has been raised whether advantage cannot be taken of Marconi's system to use balloons as actual engines of war, and whether decisive results could not be obtained by their use. Doubtless there is in this case, as in most branches of work, a certain amount of information which is jealously guarded as confidential, but we believe that it would be found chiefly to refer to methods of application and practical details which hardly affect the broad question as to the power at our disposal, which is no doubt sufficiently startling and suggestive. Expressed in popular language, we have by the application of wireless telegraphy the power to drop and fire an explosive at a great distance, say, ten miles off. This may be carried out in the following way:—A free balloon may be charged with the explosive, and with gear for releasing it and firing it. It may, for example, take the form of a shell charged with high-explosive and with a percussion fuze. The sensitive apparatus which responds to the electric discharge at the directing point is also set up in the balloon, and with a suitable wind this balloon is set free, no living occupant being in it. Its position may be followed by observers stationed at the extremities of a sufficiently long base line to give some measure of accuracy, and on the signal being given the shell is released. This sounds formidable enough; there are, however, various difficulties and objections. First, it is very difficult, perhaps impossible, to cause the balloon to travel exactly over the desired spot. If the directing or starting-point is ten miles off, it may be questioned if the balloon would ever travel over a desired mark of small area; and if the mark is of large area, it may be questioned what good would be effected by it. We know, in fact, that it has been deliberately laid down by high authorities that, in the attack of a fortress, all shells are wasted which do not strike an actual gun or a magazine. This must, no doubt, be subject to some modification; but it is generally true that the useful targets are very small objects, such as it would be hopeless to get a free balloon plumb overhead from a distance approaching ten miles. Thus the balloon attack would resolve itself into one of general bombardment. This is open to grave objection. It generally means a useless destruction of life and property, for rarely indeed has any reasonably strong place been captured by such means. Further, at the Hague Conference, if we remember rightly, this particular form of attack was one given as an example of brutal, unpermissible warfare. For purposes of conflagration it might be effectual; even at very great range a town might be set on fire, but the gain is questionable, and under most circumstances would be an unjustifiable act, and one which would provoke the condemnation of civilised nations. At a comparatively short range, probably a more definite and less general blow might be struck, but the question then arises whether it would be as effectual as shell fire. A much larger charge of explosive might probably be employed, but a charge out of proportion to the case or shell which it bursts may effect very little; a 6in. gun discharges a projectile of 80 lb. or 100 lb. weight; a 4·7in. gun, of 45 lb. weight. Thus, a balloon load is soon made up with the weight of shell and other necessary gear. The strong point in favour of such attack is that the shell having no onward velocity is specially adapted for searching behind cover which is difficult to reach with high angle fire, and impossible with shrapnel, from ordinary field guns. There are circumstances probably, then, when something might be done by balloon attack of this kind; but whether it would be considered legitimate warfare is doubtful. Probably many of our readers may think with us that it may be better to employ balloons in the unquestionably valuable work of observation and direction by signals from captive balloons, which have already performed most important functions in discovering the position of guns whose smokeless discharge renders it peculiarly difficult to locate them. A somewhat similar case may be found in the adoption of the dynamite gun fired from the United States vessel Vesuvius. The shell of this gun had appalling explosive power. The gun was employed in the attack of Cuba, but the total failure in accurate direction so discredited the gun that its development during three or four years ended in complete disappointment.

THOMAS HENRY ISMAY

THOMAS HENRY ISMAY.

WE are sorry to say that Mr. T. H. Ismay died on the 23rd of November, at his residence in Cheshire, of heart failure. He was born in Cumberland in 1837, and in early life he entered the service of Imrie, Tomlinson, and Co., of Liverpool. This was a considerable shipping firm, and in their service Mr. Ismay acquired much knowledge of service to him subsequently. We next hear of him in partnership with Mr. Nelson, and then in business on his own account. The work being done by the National Steamship Company led him to believe that there was room for yet further additions to the Atlantic fleet. The result of this conviction was the celebrated White Star line.

For several years a White Star Line of clipper sailing ships had been in prosperous existence. Steam threatened to supersede it. In 1867 the managing owner retired. Mr. Ismay took over the flag, introduced iron vessels instead of wooden ships, and two years later, when he deemed the time ripe for the introduction of a first-class passenger service between Liverpool and New York, he, with some friends, decided to form the Oceanic Steam Navigation Company, which has since become world-famed as the White Star Line. Shares in the new company were privately subscribed, and, at Mr. Ismay's suggestion, it was decided to introduce steamers of a very superior type. With this object in view orders were given to Harland and Wolff, Belfast, for the construction of a fleet of high-class steamships, and the arrangement of their internal accommodation was largely suggested by Mr. Ismay himself. We have, we may add, the late Sir Edward Harland's authority for saying that the price of the steamers was never fixed beforehand. They were to be as good as they could be.

Mr. Ismay, some months subsequently, took Mr. W. Imrie into partnership, and so came into existence the great firm, Ismay, Imrie, and Co., the owners of the White Star Line of Atlantic steamships. The first ship of the new line was the Oceanic, which made her maiden voyage in 1871. The vessel was in many respects different from all her predecessors: she was indeed the first of the "floating hotels," and she was quickly followed by other magnificent vessels, speed was aimed at and attained from the first; and so far back as September, 1871, the Baltic made a passage from Queenstown to New York in 8 days 19 hours 52 minutes; while the same vessel in January, 1873, made the voyage from New York to Queenstown in 7 days 20 hours 9 minutes. Other vessels of the line have subsequently made equally good passages, the White Star steamers holding the Atlantic record between 1873 and 1884. Mr. Ismay was always on the alert for improvements. His one rule was that the White Star fleet should have the best of everything, and the splendid reputation enjoyed by the fleet bears ample testimony to the success with which he carried out this policy.

Mr. Ismay was a man of very great ability and no small tact. Always courteous, he was always respected. He possessed the special merit of doing the right thing in the right way, and his judgment was so sound that even those at first unwilling to accept his views as sound, ultimately came to admit that he was right. It is not remarkable that the services of such a man were eagerly sought after. He was a director of the London and North-Western Railway Co., and the Royal Insurance Company. He was also chairman of the Liverpool and London Steamship Protection Association, and chairman of the Audit Commissioners of the Mersey Docks and Harbour Board. He was a member of Lord Ravensworth's 1884 Admiralty Committee to inquire into the contract system as compared with the dockyard system of building and repairing her Majesty's ships. In 1888 he was appointed a member of Lord Hartington's Royal Commission on the administration of the Army and Navy. In 1889 he was elected chairman of the Board of Trade Life-saving Appliances Committee, under the Merchant Shipping Act. Later, in 1891, he served on Admiral Sir George Tryon's Admiralty Committee on the Naval Reserves, and in the same year was appointed a member of the Royal Commission on Labour. In 1895 he was a member of the Board of Trade Committee on Side Lights, presided over by Sir Francis Jeune, and was recently nominated by H.R.H. the Prince of Wales—President—to serve on the Royal British Commission for the Paris Exhibition in 1900. On the 20th July in the present year the freedom of Belfast city was presented to him at the Town Hall. In the Jubilee year, 1887, he gave £20,000 to form a pension fund for old sailors, and in various other ways he helped the sailor and the widow and the orphan.

It is not remarkable that the death of such a man has caused general regret in Liverpool and Belfast. Indeed, his loss is national rather than local. It is an old truism that gaps in the ranks are quickly filled, yet it is not quite certain that the new man is, or ever can be, quite what his predecessor was, and it will be no ordinary man who can take Mr. Ismay's place.

THE provisions of the Steam Boilers and Prime Movers Act is to be extended to all parts of the Madras Presidency.

ELECTRO - MAGNETIC SEPARATOR

AN ELECTRO-MAGNETIC SEPARATOR.

AN electro-magnetic separator, designed by Mr. John Bromilow, of Heywood, near Manchester, for dealing with metal filings and ash metal in brass foundries and engineering works, is being introduced by Mr. James F. Butterworth, 28, Queen-street, London, E.C. The main feature of this apparatus, of which we give an illustration, is the adoption of electro-magnets in place of permanent magnets, which enables the magnets to be controlled, and secures a constant magnetic force that is not obtainable with the permanent magnets hitherto mainly in use. Another special feature is a patent automatic knock-off motion, whereby the magnets are demagnetised for a small portion of each revolution, allowing the iron collected to drop into a receiver, and leaving the magnets free for a fresh collection. The apparatus consists essentially of a conical rotating drum in connection with a trough, and carrying on its periphery a number of electro-magnets arranged in rows.

The wires of each row of magnets are connected at one end to an annular brass ring fixed in insulated segments concentrically to one end of the drum, the other extremities to a plain ring with brush contact; each segment receives the wire of a row of magnets. On one side of the annular ring is arranged in contact a segmental brass ring, which always exposes about a third of the annular ring. The annular ring is connected to a suitable electric source, and is stationary in relation to the segmental ring, and is set up against the sides by means of a spring. The trough underneath the drum runs parallel with the drum periphery, and extends a short distance below the centre of the latter, its upper end being provided with a hopper, furnished with a feed worm, and its lower end with an outlet. The metal cuttings to be separated are placed in the hopper and conveyed by the worm to the trough. When the drum is rotated the rows of magnets passing under the segmental ring are magnetised, and, in going through the cuttings, pick up the iron or steel filings, whilst, as the row of magnets leaves the ring, it instantly becomes demagnetised, with the result that the iron or steel cuttings fall by gravity into a receiver underneath. With each revolution of the conical drum the filings, as they are separated from the iron or steel particles, are gradually carried forward to the outlet and discharged into a receiver. The illustration we give shows the separator with its own dynamo, the power necessary to drive the combination being about 1-horse power actual, and the dynamo requires to be driven at 1800 revolutions per minute. In cases where current is available from other sources—and this is now very general in modern engineering works—advantage can, of course, be taken of this, and the separator adapted to suit the voltage of supply.

The apparatus is very compact in arrangement, the height over all being 4ft. 6in., and it is claimed that the output is two tons per day as a minimum. This new separator has we understand, already been adopted, with very successful results, at several large engineering works in the country, and, in addition to the advantages already referred to, it is an important labour-saving appliance, little or no skilled attention being needed beyond occasional lubrication, the filling of the hopper, and the subsequent removal of the separated metal.

A NEW RADIATOR.

THE principle of the "Thermoscopic Loop" steam trap which we explained some months ago has now been applied by the makers—Fell and Co., Upper Baker-street, London, and F. Lamplough, Green-terrace, Rosebery-avenue—to a radiator for keeping rooms or railway carriage compartments at any desired temperature. The apparatus is illustrated by the annexed cut. It is quite small, measuring only 18in. by 6in. by 4in.; it is to all intents and purposes a thermoscopic loop trap, around the limbs of which have been cast a number of deep ribs to present a large radiating surface. When a steam trap is used with the usual form of steam heater it is not infrequently put outside, and is thus at a lower temperature than the compartment, with the result that it is almost always working, and there is consequently a loss of steam and an irregularity of temperature. In the present case the radiator is its own trap, and it can be so adjusted that the valve will only open at the desired temperature, even though the apparatus is full of water instead of steam, and will close again immediately the temperature of the surrounding atmosphere has come to the desired point. The reason of its delicacy may be said to depend on the rate of transfer of heat. When the external temperature is lower than that of the radiator, heat is transferred at such a rate that relative movement of the two limbs takes place, the valve opens and more steam passes until the temperature of the outer air is raised to a point at which the transfer of heat through the radiator is so slow that the valve almost or quite shuts. The apparatus calls for no special description. The steam is admitted through a valve controlled by the hand wheel, passes down the first tube round the bend and out through the automatic valve; the adjustment of which is made by the square-headed screw seen in the engraving. A lever with unequal arms joins the two limbs near the bend. A rod passes from this lever to the valve casting, where it is pinned. The arm on the automatic valve side passes through a stuffing-box, and the arrangement of the leverage causes a slight movement between it and the valve to take place when the apparatus expands with the heat. We understand that several of these radiators are now being tried for railway carriage heating. The valve thus either opens or closes as the case may be.

THERMOSCOPIC LOOP RADIATOR

MINERS' WAGES.

IT is now definitely settled that the Executive of the coalowners and the officials of the Miners' Federation of Great Britain are to meet in London on December 7th to reconsider the question of miners' wages. This decision was announced at a meeting of the Council of the Yorkshire Miners' Association held at Barnsley on Monday, the conference between the two bodies having been suggested by the representatives of the men. Mr. Pickard is so confident of the issue that he told the Council of the Association on that day that he did not think there was much fear of the advance being obtained. The coalowners were doing exceedingly well, many of them, Mr. Pickard declared, admitting they had never known such good times since 1872-73-74. We believe it will be found that Mr. Pickard's anticipation will be justified by events. It is quite true that the values of coal have been rising steadily during the whole year. Everything that has been bought in the open market fetches a higher price than that now being delivered by contract, and such railway companies as renew their agreements in January next will be required to pay an advance of half a crown a ton on the rates charged under the expiring contracts. It has to be remembered, however, that these advances are not all gain. Miners' wages have gone up, and when the new 5 per cent. is conceded colliers will be paid the highest scale they have received for a long period of years. Then it has to be borne in mind that the coalowner pays a great deal more for stores and materials, as well as labour of all sorts connected with bringing coal to bank. There is at present the additional disadvantage of the railway companies being unable to handle the traffic which is sent to them, and that is so serious a drawback that in the case of several collieries it means the loss of one or more "shifts" in the week. Notwithstanding these drawbacks there is little doubt that the 5 per cent. asked for by the miners will be obtained, the coalowners being more concerned about securing a continuance of the Joint Board of Conciliation, which has assured steady work and prevented any deplorable differences between the masters and the men. We gather from the speech of Mr. Pickard and other leading union officials, that there will be no opposition on the part of the men to the continuance of the Conciliation Board, and the country may therefore look forward with confidence to peace and prosperity in the coalfield for another definite period to be mutually agreed upon next week.

ENGINEERS AND CANADA.

THE importance of Canada to the home industries has been a matter which has just been brought before the commercial public prominently by two trade authorities whose views are well worth attention, namely, Lord Strathcona, High Commissioner for Canada, who has been lecturing on Canada before the Birmingham Chamber of Commerce, and the President of the Board of Trade, Mr. Ritchie, who made the growth of commercial intercourse between this country and that one of the topics of his annual address to the Chamber of Commerce of Croydon. That Great Britain at present possesses the bulk of the trade is clear from Lord Strathcona's reminder that the imports into Canada from the United States and Great Britain in 1898 were respectively 78 million dollars and 32 millions. And that our trade is growing is equally evident from his further remarks. He points out that it is only since August, 1898, that the privilege of a 25 per cent. advantage over goods of foreign origin has been enjoyed by British manufacturers, yet "returns show that, whereas in 1897, Great Britain only sent to Canada goods of the value of £5,038,138, in 1899 the trade had increased to £6,178,684." Members of the engineering and the iron and steel and machinery trades in the United Kingdom will agree with Lord Strathcona in his expression of satisfaction at the way in which the Canadian Government aids, as far as practicable, the construction of railways. What Canada needs is railways, machinery, capital, and people. The High Commissioner points out that, without overcrowding, there is room for fifty to a hundred million people. The President of the Board of Trade, speaking at Croydon, showed that as a consequence of the new preferential tariff, our exports to Canada have increased in value during the twelve months ended June last by 11 per cent., while, during the same period, the American exports to Canada increased to the extent of only 5¼ per cent. During the three months ending September last our increase has been as much as 16 per cent. English engineers will do well to cultivate assiduously this rapidly-expanding market.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ECONOMICAL HAULAGE.

SIR,—The important questions raised in your article on the above encourage discussion, because the economies due to increased capacity of rolling stock will be more clearly appreciated by close study of the question, and by consequent elimination of vague generalities from the fundamental statement of the case.

The American practice of referring all items of expenditure to the basis of the net ton mile has contributed to reduce the problems of transport to an exact science, whereas investigation based on the train mile unit will exhibit on the surface no indication of a possible benefit from increased capacity.

The explanation of the increasing prosperity of American railways, concurrently with decreasing rates appears to lie chiefly in the introduction of larger engines and wagons. In the following table a few of the leading items in the latest returns of the Grand Trunk Railway are compared with those of the railways of the United Kingdom:—

	United Kingdom. Per cent.	Grand Trunk Rly. Per cent.
Working expenses, per cent. of receipts ..	58·5 ..	65·46
Increase of receipts for 1897-98	2·04 ..	5·96
Increase of expenses	5·4 ..	4·87
Increase of train mileage	3·47 ..	1·44

The Canadian line appears to be handling a largely increasing business with better economy and with very trifling additions to train mileage, whereas the British lines are increasing both their train mileage and their expenses more rapidly than their receipts.

Prominent English railway officials appear to admit that increased capacity would be a source of economy, and their inaction in this connection may be attributed principally to the difficulty of reconciling the varied interests involved in a radical change without disturbing too abruptly the conservative methods of traders.

Accurate statements of the tare weight of existing wagons are so rarely met with that the annexed table, giving particulars of representative types from actual practice, may be of value. Mr. S. W. Johnson, in his presidential address to the Institute of Mechanical Engineers, stated that the ratio of load to tare of the coal wagons on the Midland Railway was 1·56 to 1, but another prominent railway official is reported to have said during a recent technical discussion that the usual British tare "was only about one-half" of the load. It is, of course, impossible to make an accurate forecast of the benefit to be expected from a new design, if 1·56 is only about equal to 2, with sufficient exactness for railway purposes.

Your own estimate of the tare required for a paying load of 30 tons is probably within the mark; accepting the Midland practice as typical, the tare would be 19 tons. There is evidently an oversight in estimating the cost of these wagons at £120; this amount is less than the present quotation for an equal weight of steel plates at the mill's; it should be increased by about 100 per cent. As the class of workmanship and materials in the large wagons should be similar to that in the smaller, whilst the number of parts requiring accurate machining and fitting is reduced, the cost per ton of tare weight should not be greater in the former case. I am informed that, some few months ago, a foreign firm were quoting all-steel wagons of some 40 tons capacity at about £180 each.

The tare of a wagon capable of loading 36 tons of coal need not exceed 14 tons; the ratio of load to tare is then 2·57 to 1, so that every 100 tons of gross train load yields 72 tons of paying load, as against 60 tons in the older type of wagon. This is equivalent to saving one-third of the deadweight, and permits a certain volume of traffic to be worked with a reduction of 15 per cent. in train mileage, and in the expenses incurred thereby, whilst every 100 yards of train length or of siding will hold 250 tons of weight; a considerable advance on the present capacity, which is about 158 tons. With short hauls this superior compactness is of great importance; and when the difficulty of getting a good daily engine mileage is accentuated by the shortness of the trip, it is doubly important that the yield per train mile should be as great as possible. The tendency of short hauls is, therefore, to intensify the necessity for increasing the capacity.

Enormous volumes of mineral traffic are worked over a considerable mileage, such as the coal traffic to London, the supply of coke to West Coast ironworks, and of coal to large consumers such as gasworks. Here the gross train load is limited only by the power of the engine, and the receipts per train mile by the ratio of the paying load to the tare. Four of the large English railways have independent goods roads, extending over a considerable length, and thus obviating the necessity for frequent stops or high speed. In the pages of your contemporary *Engineering*, June 9th, I endeavoured to show that the cost of locomotive power alone in working coal traffic between Kettering and London could be reduced by upwards of 40 per cent. by doubling the hauling power of the engines, and by using wagons of high capacity. If such results can be approached in practice—as seems probable from the results of actual experience in America, Australia, and elsewhere—it would surely be worth while for even the most sceptical of British railways to expend a few thousand pounds in the experimental working of a section of its traffic in the manner indicated.

It may not be practicable to design an engine equal in power to the recent American example to which you refer, whilst keeping within the restrictions of our limited load gauge; but if there is considered to be any difficulty in getting out an engine to handle trains twice as great as those now working the London traffic, I shall have much pleasure in furnishing the necessary design.

Experiments conducted on the Paris-Lyons Railway have demonstrated that the resistance of the leading half of a 600-ton coal train is 20 per cent. greater than that of the trailing half, though the leading end is shielded by the engine, and the trailing end suffers the retardation due to the wake; possibly this is chiefly due to the fact that the skin friction of the leading portion, entering relatively still air, is greater than that of the following portion, which is surrounded by a belt of air already urged forward by the action of the leading vehicles. A long train might, therefore, be expected to have 10 per cent. less tractive resistance than two trains of equal combined weight. The importance of a reduction of 50 per cent. in the wages of drivers—if not of firemen also—is emphasised by the fact that in working mineral traffic on the Midland Railway the remuneration of these useful and efficient servants amounts to 35 per cent. of the total locomotive expenses.

No alternative proposal of equal promise in economy is at present under consideration by British railways; it is idle for traders to expect concessions if working costs continue to increase, and they must therefore be prepared to sacrifice what comfort and convenience may result from the present practice of dealing with bulk traffic in retail consignments of seven, eight, or ten tons, if they seriously desire to secure reduced charges.

J. D. TWINBERROW, A.M. Inst. C.E.

13, Moseley-street, Newcastle-on-Tyne,
November 23rd.

Table of Net and Tare Weights of Wagons of various Types in Actual Use.

Owner.	Load-tons. T.	Tare. T. c. q.	Ratio of load to tare.
English railway	7	5 6 0	1·32 : 1
"	7	4 15 0	1·47 : 1
"	8	5 13 0	1·41 : 1
Scotch railway	8	6 5 0	1·28 : 1
English railway	8	7 8 0	1·08 : 1
" "	10	5 15 0	1·74 : 1
" "	10	5 15 3	1·72 : 1
" " ..	10½	6 10 0	1·61 : 1
" private owner ..	10	6 8 1	1·56 : 1
" " " ..	10	6 18 0	1·45 : 1
" " " ..	10	7 9 0	1·34 : 1
" railway	12	7 18 0	1·52 : 1
" "	20	15 13 0	1·28 : 1
" "	20	27 4 0	0·74 : 1
Indian "	17	7 0 0	2·42 : 1
American "	44½	15 6 0	2·91 : 1
Australian " ..	23	11 6 0	2·04 : 1
	kilos.	kilos.	
Continental railway	10,000	4 880	2·05 : 1
" "	15,000	7,800	1·92 : 1

SIR,—In a leading article in your current issue I read the following sentence:—"If, say men like Mr. Acworth, goods can be hauled in the United States at such low rates, they ought to be moved here for not more money." What other people may have said I know not, nor even whether their resemblance to me is supposed to be physical, moral, or intellectual. But I beg to say that I never made, or dreamt of making a statement so idiotic as that which you are good enough to father upon me and my like, and that, in fact, ten years ago after a visit to America for the special purpose of studying the conditions on the spot, I wrote a book—"The Railways and the Traders"—mainly to show how impossible it was to imagine that English railways could carry at American rates. What I have said, and am prepared to repeat, is that the difference between English and American rates—say on coal, two miles and ten miles respectively for a penny—is wider than the difference in circumstances justifies; that American experience has lessons which English railway men would do well to study more carefully, and that English railway business is the only wholesale business in the civilised world which is still being carried on by the methods and at the prices of thirty years ago.

As I am writing perhaps I can give you some figures which your leader asks for. The coal burnt by the monster Illinois Central engine is put down by the *Engineering News* as costing 15 cents per mile. You estimate a consumption of 300 lb. per mile, and think this involves an impossibly low price on the tender. But 15 cents for 300 lb. = 112 cents per long ton. I should be greatly surprised if the Illinois Central pays anything like as much. The general manager of a neighbouring line, the Wabash, told me in 1897 that his coal cost him, on the average for the year, 65 cents. The Chesapeake and Ohio paid last year, if I am not mistaken, only 54 cents. Certainly a dollar a ton is an ample estimate, even allowing for the present boom in the coal trade. Then you allow the locomotive "a running day of ten hours, which is high for a locomotive." But you may take it for granted that an American engine is at work at least twenty hours per diem. This at once turns your assumed 30,000 miles per annum into 60,000. If you will obtain figures, say, from the Cleveland division of the Pennsylvania, or the Connelsville division of the B. and O., you will, I think, find the average freight locomotive performance much higher even than this, probably about 8000 miles per month. In any part of the States I am acquainted with a master mechanic, who only got 30,000 miles per annum out of his engines, would be sent about his business exceedingly promptly. Then you say, "The cost of such an engine cannot be less than £5000; it is probably much more." I have little doubt that the actual price paid was not more than 14,000 dols.; even now I expect Baldwin's or Shenectady would take an order for a similar engine for not more than 18,000 dols. Further, you give the price of three "ordinary"—presumably English 10-ton—wagons as about £120. In August last, the manager of the Gloucester Wagon Works, in his evidence before the Accident Commission, put the price at £60 to £70 a-piece. The American price for 110,000 lb. steel coal cars—30-ton cars for coal are quite antiquated in the States—was 1100 dols. a year ago. Last August it had risen to about 1400 dols. So for wooden trucks to hold 50 tons the English charge is from £300 to £350, while for a steel car of the same capacity the Americans pay about £280. Again, I may say that no engine, however large, has more than the ordinary two men on it. The question has been raised, and the firemen on the Pennsylvania lines west of Pittsburgh sent a deputation to their general manager on the subject the other day, but were convinced without much difficulty that the demand for an extra man was unjustifiable.

As for the saving obtained by running—I will not say, as you do, one train of 1500 tons instead of two of 750 tons, for toy trains of 750 tons are long dead on the coal lines, but one train of 2590 tons instead of two of 1250 tons—the wages of a train crew, engineer, fireman, conductor, and three brakesmen, are about 10d. per mile. Tenpence per train mile is a good, solid economy to start with, to say nothing of the fact that the fewer units into which the total traffic is divided, the greater is the tonnage capacity of the line, and that a engine hauling 3000 tons costs a good deal less for coal, water, oil, repairs than two engines each hauling 1500 tons, besides being much cheaper to buy at the outset.

One word more. I have just read of a trial run of this Illinois Central engine. The load was eighty-three loaded cars—say, 3320 tons.

W. M. ACWORTH.

18, St. James's Place, S.W., November 20th.

SIR,—Referring to a recent article of yours comparing English with American railway trucks and methods of working goods traffic, from an economical point of view, may I point out a great saving which could be made in this country and in America by utilising returned empty wagons? It is only a question of management, and by a little co-operation among the different railway companies, might be the means of saving several thousands of pounds annually, which are now absolutely wasted by the running of empty wagons.

At present each railway company has its own wagons, and owing to the high rate of wagon hire agreed upon between the different companies—about one-third of a penny per ton per mile—it is more profitable for a company to send its own wagons on to another company's line loaded, than to use that company's wagons, should they be on its line. The consequence is that two wagons travel—the one empty home, and the other loaded for the same company's line. This is to be regretted from an economical standpoint. The fact is, the allowance made for wagon hire is an old one, dating almost from the commencement of the railway system, when railway wagons were much more expensive to build and maintain than now, and consequently the charge has become obsolete and excessive.

New regulations should be made which would give substantial advantages to companies loading empty wagons homewards, but at the same time safeguard the interests of those companies who have invested more largely in wagons than others, such as the Midland and North-Eastern companies. If each company loaded return wagons as far as possible, the number of railway companies' wagons running empty would be reduced almost to nil.

As to private-owned wagons, which are nearly all used for mineral traffic, these almost invariably run empty on the return journey; but if all the railway companies would undertake the provision of wagons for mineral traffic at a low rate of wagon hire, the numbers would be reduced almost to vanishing point; only those being kept in private hands which by reason of some peculiarity or other were adapted for one class of traffic only, such as tank wagons, &c.

If such a saving could be made as I have pointed out, the result would be that the railway companies would be able to carry goods at an even lower rate than at present.

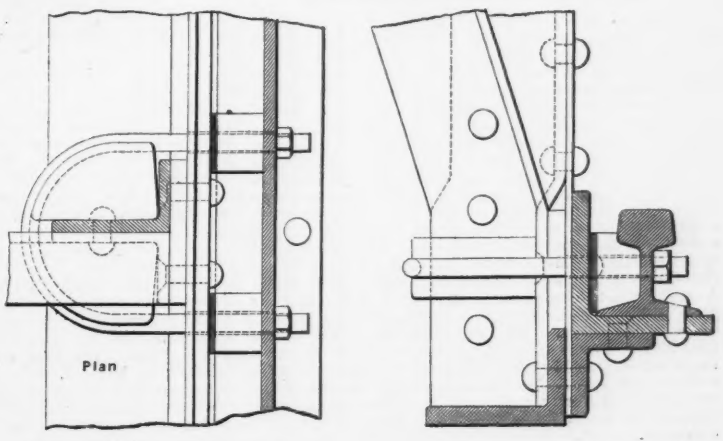
TRADER.

THE GLASGOW CORPORATION TRAMWAY CONTRACTS.

SIR,—In THE ENGINEER for October 13th, "Crane Maker," in criticising the method of supporting the trolley rails in the Sellers travelling cranes, states that "It is usually a flat-bottom rail, and is simply riveted to the leaf of an angle iron along the inner side of the web plate." Now, as this statement is not true, and is calculated to injure a reputable manufacturer, it does not seem just to let it pass without refutation. "Crane Maker" is either a very poor observer, or else he has been grossly misinformed. He has certainly missed the actual construction of the cranes he criticises.

I am in a position to state emphatically that Wm. Sellers and Co., Incorporated, of Philadelphia, U.S.A., the parties referred to, have never made a crane bridge with the rails supported exactly as described by "Crane Maker," and no doubt would condemn the arrangement even more strongly than "Crane Maker" has done.

In the construction described the whole concentrated weight on the rail is applied to bending down the horizontal leg of the angle, which has very little strength in a vertical direction. But in the Sellers construction as actually made, a type of which is shown in the sketch herewith, the rail is secured by strap bolts passing through the web and around heavy vertical angles or stiffeners, which are spaced at intervals of, say, 3ft. or 4ft., the load being delivered by quadrant blocks close to the corner of the angles.



In this manner a stout abutment is formed, and the bend is resisted by the full strength of the vertical angle, and no risk is run of exceeding the strength of the leaf of the shelf angle before its bending strength as a whole is developed. Between the abutments, the rail and shelf angle act together to support the load, the latter being further assisted when necessary by the lower flange angle, which is reversed for the purpose. As "Crane Maker" pertinently says, "there are variations of detail," but in every case great care is taken to provide strength enough to suit the best engineering practice of this or any other country. The charge has been made in America that our constructors are apt to copy American ideas with the essential features left out. This is a grave charge if true, and "Crane Maker's" letter seems to afford some confirmation.

ENGINEER.

London, November 15th.

AMERICAN COMPETITION.

SIR,—My attention has been called to a letter from the British Insulated Wire Company on the subject of the Dublin United Tramways cable contract, which appeared in your issue of last week. This letter is not only a libel on Mr. Parshall, the consulting engineer of the tramways company, but it is an aspersion on the character of the directors, imputing as it does that they failed in their duty to their shareholders. As Chairman of the Dublin United Tramways Company, I took an active part in the settlement of all the contracts for the electrical conversion of the tramways, and I am perfectly familiar with the conditions under which the cable contract was awarded.

The specifications and conditions on which the British Insulated Wire Company and the National Conduit and Cable Company tendered were identical, and the tender of the latter company was accepted because the price was lower and the guarantees better than in the offer of the British Insulated Wire Company, while any subsequent variations from the conditions in the original tender were made in the interest of the tramways company. As the conditions included an indemnity against infringement of patents, the tramways company were not interested in the results of the suit for infringement brought by the British Insulated Wire Company and referred to in their letter. The success of the plaintiffs in this action was, I may mention, limited to a small portion of cable landed in Dublin before September 2nd, 1898, the date when their patent expired.

It is not true, as stated in the letter of the British Insulated Wire Company, that "the tram company loaned to the National Conduit and Cable Company the services of their engineer—Mr. Parshall—to supervise the drawing in and jointing, so that this work, although carried out at the contractors' expense, has not been effected by him as provided for in the original specification." This work was, in fact, effected by highly-skilled men under the supervision and direction of a representative of the National Conduit and Cable Company, who remained all the time in Dublin in special charge of this part of the work. Mr. Parshall and his representatives gave the same supervision and inspection to this as to every other part of the works, to see that they were done in an efficient and proper manner. The conduit and cable system now laid down in Dublin has completely justified our selection of contractors, who have performed their work efficiently and well, and from whom we got no delay in the opening of our traffic by electrical working.

I am astonished that a responsible body like the British Insulated Wire Company should have been betrayed into publishing such reckless charges, especially as they have quite recent evidence of Mr. Parshall's impartiality, knowing that on his advice I accepted a tender from them, subject to guarantees for cables, amounting to over £10,000. The general tendency in this country to municipalise tramways has tended to retard electrical developments, as municipal bodies move slowly, and only a very limited field was opened for private enterprise. Under other conditions prevailing in America, enormous strides have been made in this industry, and huge manufactures have sprung up to meet the demand, the extent of which is hardly realised in Great Britain. America has in consequence got a long way ahead in the manufacture of plant required for electrical installation.

If British manufacturers are to make up the leeway, they will be more likely to succeed by learning from the larger experience in this business of their competitors across the Atlantic rather than by imputing unworthy conduct to honourable men as a reason for their failure to obtain a contract in competition with American manufacturers.

WM. M. MURPHY.

39, Dame-street, Dublin,
November 22nd.

DEACON'S PIPE BRUSH.

SIR,—In the last number of THE ENGINEER you were good enough to illustrate the turbine brush used in the Vyrnwy main, as described by me at the Institution of Mechanical Engineers on the 27th ult. Those who have not read a further account might be misled by the reference to "a peaty deposit," as the material which had caused the obstruction so successfully removed by the apparatus. In the course of my remarks I had used the words "so-called peaty deposit," but I was careful to explain that this deposit turned out to consist mainly of oxides of iron and manganese; the quantity of organic matter being quite unimportant. I stated, moreover, that the deposit in other mains, commonly believed to be of a peaty character, was very generally of the same nature as this.

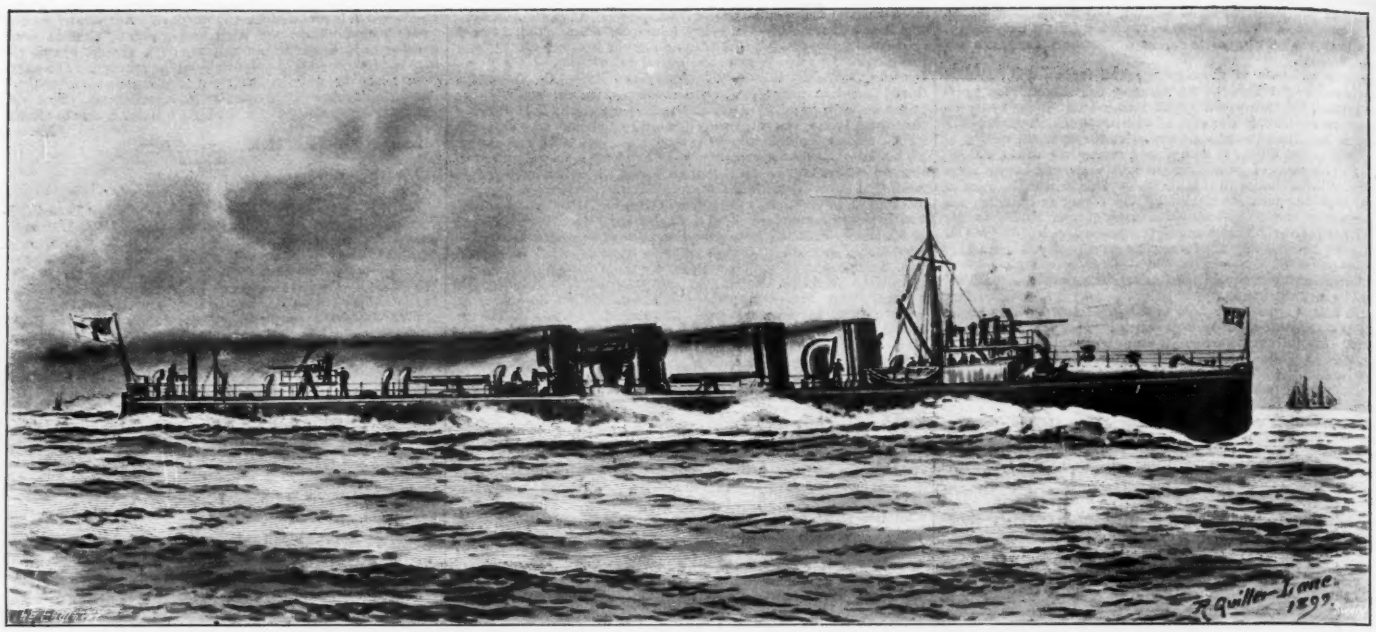
GEORGE DEACON.

16, Great George-street, Westminster,
November 30th.

HEXAGON TURRET LATHE.—In view of the complete detail with which the drawings of their differential chuck is reproduced in our Machine Tool Supplement, Alfred Herbert, Limited, have requested us to state that the differential chuck is a patented invention.

H.M. TORPEDO BOAT DESTROYER VIPER

THE PARSONS MARINE STEAM TURBINE COMPANY, LIMITED, WALLSEND-ON-TYNE, ENGINEERS



THE DESTROYER VIPER.

THE accompanying drawing represents H.M. destroyer Viper, a vessel on which a great deal of interest is being centred just now. Her machinery is the latest development of the Parsons steam turbine, and it is anticipated that her speed will be greater than that of any other vessel in the world. She is of about the same dimensions and displacement as the normal British destroyers, but has rather more boiler power, and it is intended that the engines shall develop close on 10,000-horse power. For the moment no particulars of her construction can be made public. Certain reports as to the speed attained on a recent trial trip have appeared in the Newcastle-on-Tyne press; we are requested to state that these are wholly erroneous. The boat has not yet been pushed. All that is made public is that the preliminary trials have been in all respects satisfactory.

VARIABLE SPEED GEAR.

THE hunt for a good variable speed gear for motor carriages has lead to the invention of many ingenious devices, some simple, some complicated, some good, many bad. We have been recently requested to see one in operation which has at any rate the merit of simplicity. Time alone can show if it

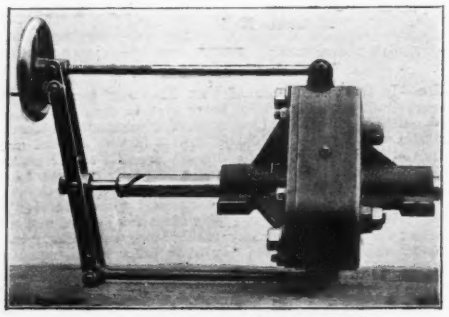


Fig. 1—NEWMAN'S VARIABLE SPEED GEAR

will be of practical utility. We have the assurance of the inventor that the wear of the parts is not excessive, but as the mechanism depends for its action on a reciprocating and intermittent motion only a prolonged trial under working conditions can prove that it is sufficiently strong and durable to work for long periods without repair. The general appearance of an experimental gear is shown by Fig. 1. The shaft is not continuous; one end of it is driven at a constant speed and the other runs at various speeds within the limits of the mechanism. Its rate is regulated by the hand wheel and screw. The internal gear is shown in Fig. 2. It consists of a spur wheel keyed or cut on the extremity of the variable speed shaft, placed centrally in the case. Three wheels mesh with this pinion. Each of these wheels is driven by a roller clutch similar to those now largely used in free-wheel bicycles. A crank pin is fixed as shown in the disc of each clutch. A plate — Fig. 3 — carries three limbs, through each of which is a hole into which one of the crank pins is carefully fitted. Inside this plate is an excentric of which the throw can be varied by means of a pin working in the spiral slot shown in Fig. 1. The excentric, it will be observed, is fitted with ball bearings; it is driven by the constant speed shaft and its motion is transferred to the three clutch which it causes to reciprocate more or less as its throw increases or diminishes. When the throw is small the corresponding partial rotation of the clutch wheel is small, and in consequence the rotation, of the variable speed shaft is also small, and *vice versâ*. It must be observed—and the point is of considerable importance—that on account of the arrangement the clutches drive in rotation and that the next one is in before the previous one is out. Were it not for this the blow on the rollers with a heavy load would certainly destroy the mechanism in a short time unless it was made excessively heavy. As it is, no appreciable knock occurs when the gear is running at its highest speed, and if continued use shows that there is not excessive wear of the parts, there should

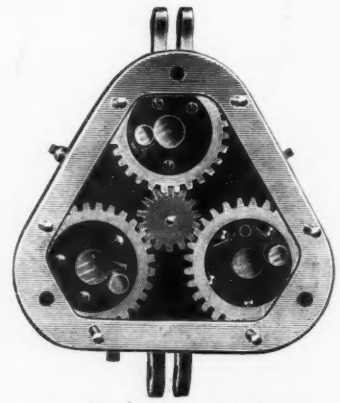


Fig. 2—VARIABLE SPEED GEAR

be no trouble in that direction. At present the work that Mr. W. H. Newman, of Totteridge Park, Herts, the inventor, is engaged upon, is some means of balancing the excentric. This is very essential, as in the existing design the vibration at high speed is very apparent. The problem is not an easy one, but Mr. Newman thinks that he will succeed in solving it without great difficulty, and he is, we believe, already engaged on the

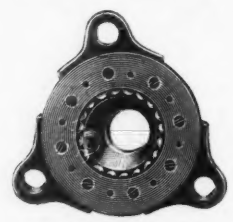


Fig. 3—EXCENTRIC PLATE

construction of a new experimental apparatus which shall be free from vibration. Whether the excentric alone is the cause of vibration remains yet to be seen. It may be found that the action of the clutches coming into gear gives a jerk to the mechanism in spite of the manner in which they are arranged. It should, by the way, be pointed out that the whole mechanism is entirely enclosed and works in a bath of oil.

DOCKYARD NOTES.

THE story of Kruger's cruiser would be the sensation of this week, but that most people incline to take it with a grain of salt. The local colour of the all lights covered incident is, however, rather too realistic to be the mere invention of a landsman, and the details are consistent. The puzzling part of the affair is "the private cruiser about which very little was known." It is rather difficult to believe in that kind of vessel outside of a book—every warship in the world is well known. And though a merchant steamer might conceivably ship a few small guns upon the quiet and start business as a pirate, to do the same thing with torpedoes and the means of using them is quite another pair of shoes. Even if by any curious combination of chances it was possible to do so—well, firing torpedoes is not a *rôle* in which a layman would be likely to cause any results outside the ship he fired them from. In fine, Kruger's cruiser is only possible on the supposition that some foreign Government were friendly to the design. And that any foreign Government would take on such a risk is tolerably incredible. Probably the inner history of the affair is that there was a fragment of suspicion, and it was considered best to do the absolutely safe thing.

THE Russian ironclad General-Admiral Graf-Apraksin—which was fully illustrated and described in THE ENGINEER some six or eight months since—is reported aground off the coast of Hogland. A special interest attaches to the matter in that her captain is the Grand Duke Alexander, brother-in-law of the Tsar, and the hope of the Russian navy. The Grand Duke was not, however, on board at the time. No details of the disaster are as yet forthcoming. The Gulf of Finland is a bad place for the navigator, as the whole south coast of Finland and its innumerable islands are rising rapidly and perceptibly yearly, so that soundings on charts soon get out of date.

THE final experiments before the general introduction of wireless telegraphy into the Navy are to come off shortly at Portsmouth, where the old Hector has been fitted up as a station. She will communicate with the Jaseur steaming off Portland.

THE French are very pleased with the rapid progress that the new second-class battleship Henri IV. is making at Cherbourg. Nearly all the armour has been put on in a month—a rapidity far ahead of anything done before—and a naval engineer, M. Moissenet, the guiding genius of the operation, is in high favour accordingly. Fifty-two plates of Harvey armour were put on, and each was put in position in three hours, according to the Cherbourg correspondent of *Le Yacht*.

THE Guichen, *croiseur-corsaire*, as the French call her, has done her full-speed trials. In a three-hour trial, with 136 revolutions, she attained 25,400-horse power—French—and a mean of 23·55 knots. The boilers are Lagrafel and d'Allest—a type that had been going out of favour somewhat.

AN armoured cruiser of 12,416 tons is to be built at Cherbourg. She will be of 24,000-horse power and 21-knot speed. The armament is about on a par with the Asama's, and she will roughly resemble that ship—a compliment to Elswick. The guns are four 8in., sixteen 6·3in.; against four 8in., fourteen 6in., and twelve 3in. in the Japanese vessel.

THE 30-knot Japanese destroyer Sazanami, built at Poplar, has arrived at Brest, and the French have been busy making the usual comparisons between her and their Durandal, which is a 27-knot boat. The difference in speed does not worry them; they know that whatever speeds British-built destroyers may make here, when they are in the open sea they don't make more than 27·5 knots, which is the speed of the Durandal. A boat which can make 27·5 knots is not subject to any toll from a sea-way. Truly, there are some things they manage better in France!

A GIGANTIC MEGAPHONE.—An enormous megaphone has been erected at Faulkner's Island, Conn., on the Government lighthouse reservation, for testing a new system of fog signals. The megaphone is 17ft. long, and 7ft. in diameter at the mouth. Attached to it is a 1½in. steam siren. The whole contrivance is mounted on a circular platform 28ft. in diameter, so that it can be revolved to any point of the compass. Different signals may be made for each point of the compass. The object of the invention is to throw the sound waves in a certain direction to the exclusion of any other direction, so that any vessel approaching the signalling station in a fog shall hear only the sound which is given when the megaphone is pointed directly at it. That is to say, if the signal means north, the fog signal must be due north of the vessel, or those on the latter could not hear that particular signal. The instrument has been tested, and it was found that the sound was heard ten miles away when the observer was standing in a line with the axis of the megaphone: but nothing could be heard of the sounds sent to other points of the compass when at a distance of a mile or more from the instrument.—*Scientific American*.

THE SHIPPING AND SHIPBUILDING OF JAPAN.

THE recent sensational report that Japan is about to try conclusions with Russia, which is alternately contradicted and reiterated, suggests some further consideration of Japan as a maritime Power. On February 25th last, we examined her position as a shipowner, and showed that at the end of 1898 she possessed 462 steamers—over 100 tons each—of an aggregate tonnage of 454,163 tons, and seventy sailing vessels—over 100 tons each—of an aggregate tonnage of 17,890 tons. This was in all 532 vessels and 472,053 tons. A considerable portion of this tonnage was, as we pointed out, composed of worn-out vessels bought for various purposes during the war, and of little or no use afterwards; but all the additions of the last two years have been vessels of the highest class, built in Great Britain, Germany, and the United States. In 1898 we built 30,191 tons of new shipping for Japan, and Japan built two steel steamers of 8000 tons each and a few smaller craft for herself, aggregating 11,424 tons in all. We also built for Japan last year three big warships and three destroyers, and America built for her two warships. And at the conclusion of our February article we said, "It is far from improbable that in the not very dim and distant future we shall see Japan firmly established as the shipbuilder of the Far East and the common carrier of the Pacific Ocean." Let us now see what progress has been made towards that development.

In the first place, then, we find an enormous increase in the tonnage now possessed by Japan. The figures we are about to give are taken from the Official List for 1899 of the Mecantile Marine Bureau of the Department of Communications at Tokyo. They come down to the middle of the present year, and they exceed those as yet published by Lloyd's, partly because they are of later date than Lloyd's, and partly because they include native-built and unregistered vessels, not included by Lloyd's. The following is the official Japanese return of registered and unregistered vessels owned by Japan:—

	No.	Tonnage.
Steamers	674	463,400
,, (Formosa)	11	800
Sailers	1310	149,000
Total registered	1995	613,200
Add registered—		
Steamers	453	Unrecorded.
Sailers	579	,,
Grand total	3027	

As in the international carrying trade it is practically only steamers now that count for much, we institute the following analysis of the steam tonnage of Japan:—

	Steamers.
Below 1000 tons gross	530
Above 1000 and below 2000 tons	68
,, 2000 ,, ,, 3000 ,,	44
,, 3000 ,, ,, 4000 ,,	16
,, 4000 ,, ,, 5000 ,,	2
,, 5000 ,, ,, 6000 ,,	1
,, 6000 tons	13
	674

Since the returns were made up a 6000-ton boat has been launched at Nagasaki for the Nippon Yusen Kaisha. To that company belong twelve of the thirteen steamers over 6000 tons, and of these ten were built on the Clyde and at Belfast. The other two were built by the Mitsubishi Shipbuilding Company at Nagasaki, who have just completed a third. The other three large boats belong to the Pacific line of the Yogo Kisen Kaisha, and were built on the Tyne, where another vessel for the same line has recently been launched. Most of the sailing vessels are small coasters, not more than half a dozen or so being over 500 tons each, and not more than a dozen or so between 300 and 500 tons. One of the largest on the register is a steel sailer of 1500 tons, which we mentioned in our previous article as among the vessels built last year at Nagasaki. Of the total registered vessels of Japan, eighty-eight steamers and eight sailing vessels are registered for the foreign trade.

It is interesting to note that Japan now stands eighth in the list of the world's merchant navies, coming closely after Italy (875,000 tons) and Russia (643,000 tons). The five premier shipping countries are, of course, Great Britain, United States, Germany, Norway, and France, in the order stated. We notice, however, that, according to the returns of the Mercantile Marine Bureau, the greatest shipowning concern of Japan has reduced its fleet—doubtless by selling old and more or less obsolete members as the splendid modern specimens of marine architecture were added. At all events, the Nippon Yusen Kaisha, which was credited with the possession of seventy-seven steamers, of an aggregate of 211,475 tons, when we last wrote, is now officially returned as the owner of sixty-eight steamers of 190,814 tons. The Osaka Kaisha has sixty-two vessels, but they total only 42,000 tons, and are engaged in the coasting and inland waters trade. The Mitsui Kaisha has seven vessels of 17,300 tons. The Yogo Kisen Kaisha has three vessels of 18,500 tons, which run between Yokohama and San Francisco.

Now, while in the present shipping returns of Japan we do not find much evidence of the large orders said to have been placed in Germany, we do find that Japan is now dispensing with our services as a supplier of new ships. In 1897 we built for her fourteen vessels of 59,425 tons, and in 1898 seven steamers of 30,191 tons, all for the merchant service; besides, in 1897, one warship of 4160 tons, and in 1898 six warships of 35,525 tons displacement. This year we have built a 6000-ton boat for the Yogo Company, and have now on hand just one small steamer of 800 tons! The three battleships mentioned in our previous article are, of course, still in hand.

What, then, is Japan doing to supply herself? Lloyd's return of vessels under construction in Japan is incomplete. In the Tokyo Register there is a list of no fewer than seventy-three shipbuilding yards in various parts of the empire, all of which must have some work or other on hand. No doubt the great majority of these yards are small, and nearly all of them are employed on small coasting vessels only. But there are at least seven private yards capable of turning out—though they may have still to import most of the material and technical skill—first-class steamers of iron or steel. There is the Ishikawajima Shipbuilding Company, at Tokyo and Uraga; the Yokbama Dock Company, at Yokohama; the Kawasaki Shipbuilding Company, at Kobe; the Uraga Shipbuilding Company, at Uraga; the Osaka Iron Company, at Osaka; and last, but by no means least, the Mitsubishi Shipbuilding Company, at Nagasaki. It is true that, according to the official returns, the shipyards of Japan have as yet only turned out in iron and steel:—

2 steamers of over 6000 tons each.
2 steamers between 1000 and 2000 tons each.
32 smaller merchant craft of various sizes.
13 gunboats and small warships (21,600 tons).

49 iron and steel vessels in all.

But then it is practically only since the war that Japan has turned her attention seriously to iron ship building. She has had to feel her way and train her young men, as the shipyards and engine shops and technical schools on Clyde and Tyne know.

The Government are leading the way. In addition to the establishments at Yokosuka, Kuro, and Sasebo, which have among them turned out within the last few years the thirteen gunboats above named, they are preparing to construct two new naval dockyards—one at the north end of Nippon, and the other near Kobe. For the supply of material to the shipyards, &c., the Government are erecting steel works at Wakamatsu, where both native and Chinese ores will be treated. These works are being so pushed forward as to be ready to start operations early next year. The sum of the situation seems to be this: that although the merchant fleet of Japan is for the moment as large as she can find employment for, it will be in the future replenished from her own rather than from our yards. And it may not be many years before Japan is both shipbuilder and steel maker for the whole Eastern world. As an ocean-carrier she is already in the running.—*The Statist.*

OPENINGS FOR MECHANICAL ENGINEERS IN CHINA.*

By Lord CHARLES BERESFORD.

ALTHOUGH the civil engineer must first clear the way, there is a great scope even now for the mechanical engineer in China, and the future offers an almost unlimited field of operations. Imagine an empire which, with its dependencies, covers an area of over four and a-quarter millions of square miles, and has a population of nearly four hundred millions of people, and then conceive this vast expanse of territory, and this multitude of people still pursuing the arts and industries with the primitive tools, methods, and ideas of two thousand years ago. The vista of untapped possibilities for the modern engineer is seen to be extensive and promising. I propose, in this paper, which your President and Council have paid me the compliment of inviting me to read to you, to divide the principal openings for the mechanical engineer under three heads, and to shortly touch upon each. I may class them as follows:—(1) Railways and electrical engineering; (2) Mining and allied works; (3) Manufactures.

Under the first of these headings, I venture to suggest that the immediate development of China will most rapidly proceed. As already shown in my book, "The Break-up of China," at the date of my visit 317 miles of railway had been completed, 2270 miles were building, 2507 miles were projected, and had been or were then being surveyed by the pioneers of your profession—the civil engineer—and 1070 miles had been projected, but no surveys had yet been made, so that altogether in the next few years we ought to see over 6000 miles of track laid, and a new and important department will have been created for the mechanical engineer in running, building, and repairing the locomotives and other rolling stock used by the Chinese and foreign proprietors of these railways. I may mention that the energy, the pluck, and the signal abilities of Mr. C. W. Kinder, who is a distinguished ornament to your profession, have already led to the erection of most extensive works at Tongshan. These works construct all their rolling stock except locomotives, but were engaged on the first engine ever attempted to be built in China at the time of my visit. Mr. Kinder estimated to be able to build engines at £1600 which would cost £2850 at home—with a twenty-four months' delivery. His greatest difficulty is the lack of skilled labour. Mr. Kinder pays good wages. The Russians who tempted some of his engineers away are now paying less than Mr. Kinder, and he told me that the men wanted to come back to him. The engines already running on the Shan Hai Kwan Railway are made by Dubs, of Glasgow, and Baldwin, of America. The American engines are much lighter, and not so good as the British, but are quite good enough for the work. The Americans use steel instead of copper or brass for fittings, and the axle, instead of being one piece of metal turned so as to leave a solid collar for the wheel, is made in three parts, the collars being separately made and screwed on to the axle. The idea that skilled native labour is cheap is quite fallacious as far as North China is concerned, the native workmen getting sixty dollars a month, about £6. During the twelve months prior to my visit, two locomotive boilers had been replaced and four re-tubed, while five locomotive fireboxes had been replaced with the assistance of native labour. Mr. Kinder estimated that the 300 miles of rail to Shan Hai Kwan cost for everything—including, that is, the admirably-fitted workshops I saw at Tongshan—about £6000 a mile. Close by the machinery shops were some cement works, but the machinery there was rusting and doing nothing. The works had been started by Chinese, but owing to their curious inability to undertake mechanical or manufacturing work without European supervision, the works had been a failure. Mr. Kinder told me that the railway alone took 60,000 to 80,000 barrels of cement a year, and there was a great demand for it elsewhere, but the works were now closed.

In addition to the labour difficulty, which can be easily overcome when skilled mechanics realise the advantages offered to them in China, there is also another difficulty to contend with—the Chinese hatred of the "foreign devil." There was some rioting and ill-feeling at the time of my visit, and two of Mr. Kinder's engineers were fired at, and also badly beaten at Fungti. As an example of the futility of British methods in China, my attention was drawn to the fact that, instead of at once demanding the punishment of the ringleaders, and the withdrawal of the Chinese Kan Suh troops who were responsible for the outrage, the British authorities summoned a conference of the whole of the foreign Ministers, and as a result of their united action two of the offenders were mildly whipped, receiving exactly the same punishment as some coolies who damaged a pump handle and a piece of hose pipe—total value 2 dols.—a few weeks before. Mr. Kinder was so dissatisfied with this that he at once withdrew his engineers, and the soldiers, emboldened by the mild treatment awarded to their comrades, proceeded to damage winches and boilers at Pei-ho-tien, and to strip off some copper tubing.

The matter was, however, soon afterwards settled, and the Kan Suh troops withdrawn.

Railways are the greatest, easiest, and speediest instruments of civilisation, and I look forward with confidence to the benefits which will accrue to China, and to British trade and commerce, by the opening of the country in this manner. The mechanical engineer has a great part to play in the near future when Stephenson's "Iron Horse" penetrates into the "Middle Kingdom," and I should strongly recommend this Institution not to overlook the great possibilities before them in this direction.

I have placed electricity under the first heading because I learn from the ordinary channels of information that since my return from China it has been rendered possible for the traveller to go from the railway station to the gates of Pekin by electric traction. I, personally, was carried into the city in a Mandarin's chair, while my staff rode on Chinese ponies, and, judging by the then state of the roads, to have so soon laid and started an electric tramway is very creditable to the promoters of the enterprise.

In the European settlements electricity is already used for lighting purposes, and even at Hankow, 600 miles up the Yangtse River, some of the firms were laying down electrical plant. The abundance and cheapness of coal will render this branch of industry—electrical engineering—a very profitable one in a short time. The Chinese of the better class are very fond of luxury after European modes, and I have no doubt that they will be ready consumers of electrical power for lighting and manufacturing purposes. Of course, all the plant must, in the first instance, be imported, and I would like to point out to this Institution that we are far behind Japan and America in the use of electrical power, and unless we are much more energetic, the vast electrical plant which China will require will come from those countries. It is more than probable that Japanese and American engineers who accompany the plant to China will be employed there hereafter instead of British engineers. The reason of this I have shown by examples in my book, "The Break-up of China." At Kioto, in Japan, I saw the great electrical plant which, in addition to lighting two-thirds of the town, also supplied the motive power for the city trams, for the pumping machinery at the waterworks, and for no less than sixty different industries in or near Kioto. The electric energy is produced by water power from a fall of 120ft. The plant is chiefly American, but the Japanese are now beginning to make their own.

In the United States—at Buffalo, in particular—I saw a similar display of ingenuity and enterprise. The magnificent falls of Niagara are utilised to produce electrical power for hundreds of industries at the small cost to the consumer of £1 per 1-horse power per month.

* Institution of Mechanical Engineers, November 24th.

Of course, Japan and America have had a great advantage over older countries like Great Britain, in the fact that it is far cheaper to start with the latest products of electrical engineering than to replace steam, gas, and other expensive systems already laid down, as we in this country have to do. The reason I have referred to this is, that China is in the same happy position as Japan and America, and the electrical engineer will have many openings before him if institutions like this will study the immediate needs of China, and assist its members to make use of their experience, industry, and ability.

Telegraphs already exist all over China, and are the Government property. They are badly managed. I was credibly informed that it is often possible to go from Pekin to Tientsin and thence to Shanghai, and to arrive before a telegram you had despatched at starting. By paying treble rates it is possible to get reasonable speed, but the service is very inferior. Telephones exist in some of the settlements, but one manager of a telephone company in China told me that all their copper wires were stolen by the Chinese, so that they had a very inefficient service with steel wires.

II. *Mining, &c.*—The mechanical engineer who has adopted that branch of his profession which has to do with mining machinery, boring machinery, hydraulics, and allied works, will find that there is plenty of scope for him at this moment in China. The country is full of minerals; coal, iron, gold, silver, copper, mercury, lead, and salt, are all to be found in paying quantities, and only skilled workers and the latest machinery are needed to develop the rich resources of this marvellous country. Labour can be had for mining work at the ordinary coolie pay of 200 cash, about 5½d. a day. Our friends the Russians are probably much alive to this important feature in Manchuria, where an Englishman showed me specimens of gold obtained by himself in the interior, and another Englishman who has lived for years in the country told me that Manchuria was a white man's country, very healthy and bracing, and with a climate, soil, and resources closely resembling Vancouver. But Manchuria is not the only place where minerals are found. All over China there are great deposits. I need only allude to the marvellous coalfields of Shansi, with seams 80ft. thick, which the Pekin Syndicate are about to work, to the resources of Shantung, where I have seen a German missionary map marked in all directions with notes of gold, coal, iron, and other minerals, also to the coalfields and iron mines of Ranyang and other places on the Yangtse, and the many other districts where minerals have been found, to show that the riches of China in this direction are incalculable. All of these vast stores of underground wealth belong to the Chinese Government. Imagine if the British Government owned all the mines in this country, and could charge a handsome royalty for the right to work them; and it will be seen how great are China's undeveloped sources of revenue.

The mining engineer must necessarily understand all about pumping machinery and hydraulics, and if at first there is little opening for him in his proper sphere, I should suggest that he made use of his knowledge in another direction. There is a great field for mechanical engineers in most of the old, and all of the newer concessions and settlements, in supplying water to the European community. At a place like Hankow, for instance, where there are no waterworks at all, there is not only the European community but the Chinese on the other side of the river, who would be glad of waterworks. At present all water has to be boiled before use, and is even then unpleasant. There is a project for supplying Canton with water, which a countryman of mine, a former M.P., is now actively engaged on.

For mining machinery, engines, pumps, and all other plant of this description there is a great demand, and only capital, and British mechanical engineers are needed to give a great impetus to our manufacturers of these goods.

III. *Manufactures.*—The abundance of coal and iron in China, make it absolutely certain that China will some day become a great competitor with us in the industrial market. But so far from fearing this competition, British manufacturers should reflect that if they are wise, and take time by the forelock, China will for many years to come be an enormous buyer of machinery and tool steel, while before the necessary reaction can come about, and we begin to feel the effects of her competition, China will have become so rich, that the increased amount of our products which she will take in one direction will counterbalance our losses elsewhere. There are other points for us to remember. (1) A poor country can never buy very much from other nations. (2) Supply creates demand, despite the seeming paradox; and (3) The volume of trade keeps increasing even if individual industries suffer. To explain what I mean:—

(1) If China is a good customer of British goods now, she will become a better customer still when she has more money to pay for them. She can only get this money by exploiting her minerals, and becoming a manufacturing country with large exports. The richer China becomes, the more she will become a purchasing power.

(2) Again, it is an undoubted fact that an increase of supply increases the demand for an article. This partly arises from the increased supply cheapening the cost both to the manufacturer and consumer. The introduction of machinery, although at first opposed by the more ignorant, has thoroughly proved this, especially in the case of Arkwright's invention of the spinning jenny in England. Another instance of this is the case of all uncivilised races, or races where civilisation has stood still, as in China. A few men only can live, and barely live, on a huge expanse of country if each subsists by the food he himself produces, but if on that same extent of country a number of men congregate and set up machinery and workshops, each becomes a specialist and supplies the whole community with an article which he and a few others alone produce, and the land supports more people than when each person supplied his own necessities.

(3) If China becomes a manufacturing country she will undoubtedly hit individual British industries, but as long as the volume of our trade increases we need not fear. Our manufacturers will make money in fresh directions. Coventry is an example of what I mean. The destruction of the ribbon trade seemed to threaten Coventry with bankruptcy, but the rise of the cycle industry has made the town ten times more prosperous.

I visited a great many mills in China manufacturing both cotton and silk. In every case I found that the mills under entire Chinese management were complete failures. Their system is to pay high dividends, and put nothing aside for depreciation of machinery, and so the whole place goes to rack and ruin, and when the inevitable crash comes it practically means laying down completely new plant. The silk industry is being killed by adhering to old-fashioned methods, and the Japanese, by introducing modern machinery, are competing to the disadvantage of China's silk trade. The tea trade is declining for similar reasons. Some remarkable facts were lately brought to my notice about the tea industry in India. The improvements which have been made from hand to machine manufacture have undoubtedly played a very great part in the steady advance in popular favour of Indian and Cingalese teas. The old hand-made process took up an enormous amount of room, required fifteen people to produce each 100 lb. of tea, and took a great deal of time. The introduction of British machinery by Davidson has led to a cleaner, more satisfactory, and more rapid mode of manufacture, which occupies a quarter of the time, and requires only one-fifth of the labour. Thirty years ago it was impossible to land tea in London under 1s. 6d. per lb.; to-day the grower, by the aid of machinery, can land and sell tea wholesale in London—at a profit to himself—for the price of 8d. per lb. I think it only right to direct the attention of mechanical engineers to these important questions of the manufacture of silk and tea, as I believe that British companies, established in China at Treaty ports on British concessions or settlements, could buy up from the small Chinese farmers large supplies of raw silk and green tea, and by improved methods of manufacture and modern machinery, produce in each of these industries a superior article, which would find a ready sale.

I have dealt so fully in my book, and in recent speeches, with the machinery of the Chinese arsenals, and the wonderful work turned out, that I will only allude to it very briefly here, and refer you to "The Break-up of China" for fuller details. I should like, however, to tell you one or two stories thoroughly characteristic of the Chinese. At Shanghai in the superb arsenal under the superintendence of Mr. Bunt and Mr. Cornish, both British mechanical engineers, I saw an Armstrong gun which had had the breech piece repaired in a most clever manner.

The Chinese were also very delighted with me at other arsenals having no European superintendent, when I showed them how to set their speed and feed gearing for the steam tools.

In referring to the openings for mechanical engineers in China, in assisting to establish manufactories with modern machinery, and under European supervision and direction, the native wage is, of course, an important point to be considered. I found that in South China the current rate of wages for common coolies was 40 cents (9d.) a day; fitters, 75 cents (1s. 5d.) a day to 1·25 (2s. 4d.) a day; smiths get 60 cents (1s. 2d.) to 1·50 (2s. 10d.) a day; carpenters, 50 cents (11½d.) to 80 cents (1s. 6d.) a day; masons, 60 cents (1s. 2d.) a day; and mill and refining hands, 30 cents or 7d. a day.

Another opening for the mechanical engineer is to establish himself as an agent for British machinery in the foreign settlements and concessions. Over and over again I saw British machinery with the name plates removed and German and Belgian names substituted, or where the name of the British firm was stamped in, it had been covered over by German and Belgian name plates. This was notably the case at the iron mines at Hanyang and at one of the arsenals, where I saw some of Whitworth's tools so treated. I pointed this out to a Chinese merchant, and he explained it by saying that the Chinese usually bought their machinery through local agents in preference to sending abroad for it. These agents, he said, were more often than not, Germans or Belgians who understood machinery. The advantages of buying locally from an agent were threefold: (1) Quicker delivery, as the machinery was often in stock. (2) No trouble about the rate of exchange increasing the cost after it was ordered. (3) The local agent could be held responsible for defects, and was available for repairs if anything went wrong. I think this is a very important point for engineering firms who are members of this Institution, and it also offers an opening for young men who are good mechanical engineers to take up the sale of British machinery, and to push it in preference to that of other countries.

In connection with this matter I wish to draw the attention of engineering firms in Great Britain to the immediate necessity of establishing an exhibition of British machinery in China, with mechanical engineers to explain and show its capabilities. The Chinese are a very practical race, and if they see what machinery can do, they will often buy it. Both the Americans and Germans are already taking steps to provide such exhibitions of their goods, and it will have a serious effect on British machinery if we allow them to forestall us.

There is one other point to which I should like to refer before leaving this subject, because, although it concerns the manufacturer of goods more than the mechanical engineer, it also affects the latter, who would be benefited by any change in the state of things I am going to draw your attention to. From various points which were brought to my notice, I was satisfied that one of the reasons why the British manufacturer fails to supply what the Chinese really want, and is losing ground against American competition, is the fact that our machinery is so often old and nearly obsolete. The British manufacturer does not write enough off his profits for depreciation of machinery, and he does not avail himself of the latest machinery, from an idea that it will not pay. The United States is far ahead of us in this respect. I recently saw a wire machine in New York which cost £1800, and was consigned to the scrap heap after twelve months, to be replaced by improved machinery. In Great Britain one man controls one block for wire-pulling machinery, whereas in the United States one man controls four blocks. The United States workmen get higher wages, but their food, clothing, and rent are proportionately dearer. In Pittsburgh eleven to fourteen kegs of nails are turned out by one man in a day, and the man gets 8s. a day wages. In this country only six kegs of nails are produced for 6s. a day. Improved machinery means a larger output for less cost, but it does not necessarily mean that the workmen suffer. On the contrary, the increased output and reduced cost of production so cheapen the article that the demand increases, and in the end more men are employed than before, and wages are also higher. If Great Britain is to retain her superiority in China as a trading nation, there must be improvements at home which will give fresh openings to the mechanical engineer in Great Britain, and this is equally true of all branches of industry. Irish butter would find a better market in England, and better prices than Danish, if the latest machinery and most improved methods of manufacture were generally adopted—a distinct case for the mechanical engineer's attention.

In conclusion, and by far the most important point for the mechanical engineer to deal with, in my humble opinion, is the question of learning Chinese. I venture to invite the attention of this Institution to the immediate necessity of training young mechanical engineers to learn Chinese, which can only be properly done by establishing a school of mechanical engineers in Hong-Kong. The official Chinese should be studied, as all well-educated Chinese learn this, but for practical purposes, and conversing with labourers, each man must become a specialist in the dialect of the province in which he proposes to work. Americans and Germans are both doing this.

For the benefit of mechanical engineers who are prepared to earn their livelihood in China, and to assist in the opening up of the country which is now going on, I will summarise the points where I think there is the best prospect of immediate openings.

(1) *Railways.*—For all work in connection with railways the advice of Mr. M. Kinder, the engineer-in-chief of the Chinese Imperial Railways, should be sought, and applications for employment should be made to the various syndicates financed by the Hongkong and Shanghai Bank, particulars of which can be obtained in my book.

(2) *Mining work* is being undertaken by the Pekin Syndicate, which is the most promising venture at present, and by Mr. Pritchard Morgan, M.P.'s, Syndicate, which has obtained valuable concessions in the Yangtse Valley. Both of these syndicates are well supplied at present with civil engineers, but there will doubtless be many openings for mechanical engineers in the near future. Electrical and hydraulic engineers should look out for the prospects of employment by the municipalities in the European settlements, and by large firms.

(3) *Advertisements* in the Anglo-Chinese papers in Tientsin, Shanghai, Hankow, and other places, should for the present be the best means of securing billets in China for mechanical engineers willing to enter the employment of British or Chinese manufacturing firms.

Finally, until there is better security for life and property, and right of residence in the interior is fully accorded, engineers should be chary of accepting even official Chinese engagements requiring them to permanently reside outside the European settlements, as it is hardly fair for men to go to places where Chinese law does not permit a foreigner to live, and then to complain that their consul, hundreds of miles away, does not protect them.

The potential possibilities of the Chinese Empire are enormous and scarcely to be calculated. To the enterprise, pluck, perseverance, skill, and knowledge of mechanical engineers I confidently look for assistance in realising the latent resources of that ancient empire, and in keeping the flag of Great Britain ever in the van, no matter in what direction progress is made.

CLEVELAND INSTITUTION OF ENGINEERS.

RAISING WATER BY AIR.

THE first meeting of the thirty-sixth session of the Cleveland Institution of Engineers was held at Middlesbrough on Monday evening, Mr. George J. Clarkson, the President, in the chair.

The secretary stated that the following ten members had been elected by the Council since the last meeting of the Institution:—Mr. Fred Worton, Blaenavon Steel Company, Limited, Blaenavon, Mon.; Mr. Douglas Gordon Cochrane, engineer, Coatham; Mr. J. L. Miller, electrical engineer, Ashmore, Benson, Pease, and Co., Limited, Stockton; Mr. Joseph Beattie, electrical engineer, Middlesbrough; Mr. S. T. Garson, assistant blast furnace manager, Middlesbrough; Mr. Robert Henry Craggs, engineer, Middlesbrough; Mr. Thomas William Lewis, Tees Ironworks, Middlesbrough; Mr. John Thos. Coates, analytical chemist, Tees Ironworks, Middlesbrough; Mr. J. H. Moysey, engineer, Middlesbrough; and Mr. Charles Wm. Barnes, Middlesbrough.

The report of the Council for the session 1898-99 was then read. It stated that the meetings of the Institution had been well attended, and the discussions interesting and instructive. An extra meeting was held in Stockton on May 29th, when Mr. J. Clifton Robinson read a paper on "Electric Traction on Tramways." In the course of the year thirty-five new members had been elected. The most prominent loss among the deaths was that of Mr. Jeremiah Head, the virtual founder of the Institution. Mr. C. H. Ridsdale, of the North-Eastern Steel Company, had been elected a member of Council, in place of Mr. A. H. Whipham, who had resigned through ill-health, and Mr. George J. Clarkson had been re-elected President.

The President proposed the adoption of the report and the statement of accounts, and Mr. J. E. Stead, in seconding, suggested that the Institution should occasionally have a kind of conversazione, such as several of the leading scientific and technical societies had. He had arranged to give on one such night a microscopical demonstration, specially illustrating the microphotography of iron and steel. The report, &c., were adopted.

Mr. Saniter proposed, and Mr. T. W. Macnay seconded, a vote of thanks to the President and Council, Mr. Clarkson replying.

Mr. Clarkson then delivered a presidential address dealing with the patenting of inventions in the British Empire. He showed that, to protect an invention in the British Empire, it is necessary to take out as many as thirty-four patents, and this did not include Bermuda, the Channel Islands, Gibraltar, Falkland Islands, British Gambia, St. Lucia, St. Vincent, Sierra Leone, Gold Coast Colony, Cyprus, Grenada, West Indies, Lagos, where similar protection is only obtainable by legislative enactment. The dates of the patent laws vary from 1857 in Jamaica to 1896 in some of our latest possessions. The provisions vary considerably. Referring to the struggle now going on in South Africa, the President remarked that it has generally been the case, as soon as British authority is established over a territory sufficiently to lay down laws for its future government, that a patent law is introduced, generally from some adjoining colony, without regard to whether the patent law of that colony is up to date or not, and this has been done in Rhodesia and elsewhere in South Africa, following the 1860 Act of Cape Colony. In Canada there has been a grouping of provinces into one Dominion, with one patent law for all. In Australia the Federation scheme now in progress will bring with it a consolidation of the separate provincial patent laws, substituting for seven different patents now required one patent covering the whole of the Australian mainland and the island of Tasmania. The termination of the struggle in South Africa should bring the like consolidation of the several patents now required to cover the continent. Then will come the question as to how to carry the process of consolidation still further, thereby attracting the inventive talent of any one part of the Empire easily and at moderate cost to every other part.

Mr. Charles Wood, of Middlesbrough and Stockton, then read a paper—of which the following is an abstract—on "Raising or Lifting Water by Air." The author stated that the system of raising or lifting water by air was discovered by Dr. Pohlé, of the United States of America. There is, he said, amongst engineers who have had experience in fixing and working pumping machinery, a fascination in fighting against the numerous difficulties which daily crop up in working many classes of pumps that only those who have gone through the experience can thoroughly appreciate. How many days and nights have been spent in trying to find out why a certain pump is failing to do its duty; and how often has a pump been pulled to pieces to examine valves or buckets, to find these all in perfect order; and, after further trials, discover the suction blocked many feet under water, or a small leakage of air in the suction pipe, necessitating further hours of labour in cutting away the nuts from rusty bolts, placed in the most inaccessible places, standing all the time in wet clothes in a dismal atmosphere, with the knowledge at the same time that you are receiving the blessing of those above for keeping the works standing. Many difficulties are met with, but the Pohlé air pump, where it can be employed, will overcome most of them, and it is simple, durable, easy of use, and economical. The apparatus consists of two plain open-ended pipes which are let down into the well. The larger of the two has an enlarged end at the bottom and is the discharge pipe, while the smaller, which leads into this enlarged end, constitutes the air pipe through which the compressed air is conveyed. These pipes are all put together on the surface of the ground and lowered to the bottom of the well. It is therefore obvious that there is no obstacle to the free movement of the water, and the full area of the discharge pipe becomes accessible for the first time in the history of deep well pumping, whilst the dispensing with all valves, buckets, plungers, rods, or other moving parts within the well or pipes commends itself. As the pump has no valves, no standing water remains in the pipe column after the operation of pumping, so the water cannot freeze except under extraordinary circumstances.

When working, compressed air somewhat in excess of the pressure due to the head of water outside the discharge pipe in the well is forced through the air pipe into the enlarged or bell-mouthed discharge pipe at the bottom. Thence the air rises by gravitation, and, by the inherent expansive force, forms alternate layers or pistons of air and water, which, in rushing upwards, lift or discharge the water layers through the top end of the discharge pipe. Thus, the pressure per square inch of the column, made up of air and water inside the discharge pipe, is less than the pressure per square inch outside the pipe. Owing to this difference, the water flows continually. The weight of the water outside the discharge, that is, the head of water in the well, is, roughly speaking, one-third greater per square inch than the aggregate air and water sections inside the discharge pipe. The water, therefore, flows by gravitation from outside to within the discharge pipe. This compressed air will not, if supplied in proper proportions, escape through the water overlying it, nor will the water fall back through the air whilst both are in an upward motion. The elasticity stored up in the compressed air jamming against the side of the pipe and against the water form temporary water-tight air pistons, which lift the water above to its final discharge without appreciable loss by leakage or slip, whilst this compressed air, after having expended its elastic energy in the work of lifting water, is dispelled with only a practically unimportant loss of power. When the bubbles are small, they will pass through the water; and, although the water column will become elongated, they will not exert the positive elevating power which follows when piston-like layers are formed.

The author then gave a table showing the elasticity of compressed air. A head of water of 204ft., he showed, is equal to 88·21b. pressure per square inch, or six atmospheres; and when the air is compressed equal to this, it occupies only one-quarter the volume of its normal bulk, and in this state it enters the bell mouth at the bottom of the discharge pipe, and, as it ascends, it expands in exact proportion as the load becomes lighter, until, when these air pistons arrive at the top, or discharge, they are of the same density as the atmosphere, and are four times longer than when they are formed at the bottom. The result of this is that, as these air pistons rise and elongate, the velocity of the water gradually increases in the same proportion—an example of a most perfect expansion engine.

The air lift pump gives 90 per cent. efficiency from the air receiver in the large size pumps, and, as a rule, 80 per cent. It retains its efficiency without repairs, or until the pipes rust through, whereas the ordinary bucket or plunger pumps gradually lose their efficiency from the first stroke they make, and this rapidly if the water contains sand, or is of an acid character. With the air pump, sand or gravel can be thrown up without affecting the working of the pump at all. The capacity of the pump is unlimited, and with a proper proportion of air to the size of the discharge pipe, will work efficiently in pipes of a considerable diameter. It is calculated that a discharge pipe 30in. diameter will deliver 16,660 gallons per minute or 1,000,000 gallons per hour. It has been ascertained that a million gallons of water can be raised 100ft. high with an expenditure of 1½ tons of good coal, or equal to under 0·112 of a pound of coal per horse-power.

An important feature of this air pump is the remarkable effect it has in cooling and aërating the water. When air is compressed the temperature rises considerably. This heat is lost, or taken up in the air compressor, in the receiver, and the air pipes leading to the well, until it is again about the same temperature as the atmosphere. When this air is liberated and brought into contact with the water in the discharge pipe it expands in rising, and in so doing it seizes upon the heat in the water, and reduces the temperature to such an extent, that in some cases it has brought it down from 10 deg. to 12 deg. below its normal temperature in the well, and the water at the same time has taken up about 2 per cent. in aëration, and become sparkling, clear, and palatable.

The compression may be any distance from the well, and many wells may be worked from the same compressor, and under complete control of the engineman; or a compressor may be worked from a water-wheel or turbine a mile distant.

The paper was illustrated by diagrams, and also by a working model of the air lift pump.

Mr. F. Herbert Marshall, of the Tees Ironworks, Middlesbrough, said Mr. Wood deserved the thanks of the Institution for opening up new ground, and for illustrating his subject in such a practical way. He thought Mr. Wood would do well to supplement the paper by giving details of the working of the pump. He—the speaker—would like to see some radical improvement on their present pumps, which had to take water from the river, and got choked up with weeds, &c., two or three times a day. He hardly saw, however, how the air lifting pump could be adapted to raising the water from the river, as at low water there would only be a 12ft. head of water. He was rather inclined to doubt Mr. Wood's statement that a million gallons of water could be raised 100ft. high with an expenditure of 1½ tons of coal, or under 0·112 of a pound of coal per horse-power. He thought the decimal point had got into the wrong place. The theoretical efficiency per pound of coal was not anything like as good as this.

Mr. Joseph H. Harrison, of Middlesbrough, said he had considered this question of air lifting pumps in connection with brine pumping some years ago, but not thinking it suitable with the brine 25 per cent. heavier than pure water, he had not pursued the subject further. He thought that it might answer to put the compressed air into the tube much nearer the surface than the bottom of the pipe, and that would be cheaper. He did not think the aëration of the water was any recommendation where boilers were concerned, but it would be an advantage where drinking water was being raised.

Mr. Robert J. Worth, engineer, Stockton, held that all the troubles with the old-fashioned pump were entirely due to bad design, or to utterly worn-out apparatus. He had known old-style pumps run for seven or eight years without stopping, and he much questioned whether they could get any better results with the new kind of pump. He did not think the new pump would be an economical one, and he doubted the raising of a million gallons of water with an expenditure of 1½ lb. of coal per horse-power—there must be some mistake somewhere.

Mr. Henry Crowe, of Middlesbrough, having spoken adversely to the claims put forth on behalf of the pump,

Mr. J. E. Stead remarked that there appeared to be something in the invention, and he would be pleased if Mr. Wood could give more details as to the working. In regard to the diameter of the tubes, he was aware that they would have no difficulty in getting the bubbles in small tubes, but they did not form so readily in large ones. He would like to know the maximum diameter of the tube that could be used. He thought Mr. Marshall's question of pumping water from the river by aid of the apparatus described could be accomplished by sinking a well, say, 100ft. deep, and letting the river water run into it.

Mr. Wood, in reply, said it was the difficulty of raising the water from the Tees for works purposes that led him to consider this question of air lift pumps. As to the diameter of the pipe, the pumps had been made with them up to 3ft. diameter, and there was no slippage. There was no reason why the pump should not work as well with brine as with water.

The author was thanked for his paper.

PRESENTATION TO MR. LEWIS J. FIRTH.—On Saturday evening a presentation was made to Mr. Lewis J. Firth, the senior managing-director of Thomas Firth and Sons, Limited, by eighty-seven of the officials, managers, and staff of the Norfolk Works, Sheffield. The presentation consisted of a fine collection of old Sheffield plate, accompanied by an illuminated address, and was in commemoration of twenty-five years' connection with the firm, Mr. Firth having commenced his business career on the date when his late uncle, Mr. Mark Firth, was elected Mayor of Sheffield.

GRADUATES' ASSOCIATION OF THE INSTITUTION OF MECHANICAL ENGINEERS.—A visit was paid to the Westminster pumping station of the London Hydraulic Power Company, at the invitation of Mr. Henry Chapman, M.I.M.E., and chairman of the company, on Wednesday afternoon, November 22nd, at 1.30 p.m., by members of the Graduates' Association of the Institution of Mechanical Engineers, Storey's-gate, Westminster. The old station was first visited, and the three sets of three-cylinder compound pumping engines and entire plant were seen in full work. These combined engines and pumps are of a very compact and strong design. The engine-room is fitted with all the necessary steam and water gauges, and is in every way perfectly arranged. A Bailey electric recorder is used to record work done by the engines. The boilers are ordinary Lancashire, stoked by J. J. Vickers' mechanical stokers, driven by a three-cylinder Brotherhood hydraulic engine. One of Green's economisers is used for heating feed-water. Water for both boilers and for use in mains is pumped from the river by low-lift hydraulic pumps to settling tanks on roof of station, and thence to filter tank, filter presses, and, finally, through charcoal before being pumped to mains and boilers. Coal used is rough small coal, and is lifted from barges by a very handy hydraulic crane worked off the mains. The extension of station, on opposite side of the road, was then visited. These works are still in the hands of the contractor. Plant consists of four sets of triple-expansion engines of the same type as those engines in the old station; engine-room is very commodious, and very well arranged. Boilers by Reiley and Fairbairn, and stoked by J. J. Vickers' mechanical stokers, coal being fed from overhead hoppers, &c.; two Green's economisers are used for heating feed-water. Arrangement of settling, filter tanks, and presses practically the same as at old station. Water, coal, stores, &c., and water mains will be taken through a subway in course of construction.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE demand for material required by all departments of the engineering trades continues very marked, but producers confidently anticipate that prices will soon go still higher than at present, and they are consequently entering into as few forward engagements as possible. It is estimated that the production of iron and steel at the Black Country works this quarter will be at least 20 per cent. greater than that in any previous quarter for ten years. Indeed, the production would have been much larger if manufacturers could have procured the necessary supplies of pig iron and coal. The steel works are particularly active, the demand for constructive purposes being greater than for many years past. Bessemer billets and blooms are quoted from £7 to £7 5s.; Siemens, ditto, £7 5s. to £7 10s.; mild steel bars, £8 10s. to £9; steel plates, £9 5s. to £9 10s.; steel girders and angles, £8 to £8 10s.

Manufactured iron is in large demand. Galvanised corrugated sheets are quoted £14 10s. to £15 f.o.b. Liverpool for 24 w.g., and plain black sheets, £10 2s. 6d. to £10 7s. 6d. for singles, £10 5s. to £10 10s. for doubles, and £10 17s. 6d. to £11 2s. 6d. for trebles. There is a good call for nail rod and rivet iron at £9 15s. to £10, whilst gas strip is active at £9 to £9 10s.

Pig iron is in large demand; some smelters are sold forward to the end of the year.

North Staffordshire, Derbyshire, and Northamptonshire pig iron agents are most of them quoting about 5s. per ton over present prices for next year's deliveries. For part-mine Staffordshire pig iron 75s. is asked, whilst all-mine varies from 77s. 6d. to 82s. 6d. for ordinary and medium sorts up to 90s. to 92s. 6d. for best. For superior sorts of foundry work cold-air pigs are required in considerable quantities, and 115s. to 117s. 6d. is cheerfully paid.

The new Priestfield Blast Furnace Works, near Bilston, belonging to the late firm of W. Ward and Sons, iron manufacturers, have been purchased privately on behalf of the Patent Shaft and Axletree Company, Wednesbury, at between £4000 and £5000.

The Patent Shaft and Axletree Company, which has acquired the works, intend to entirely re-model them on an improved blast-furnace system, as some of the plant is out of date, and the furnaces will have to be re-lined, and other considerable expenditures incurred.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Activity continues to be maintained in all the leading iron-using industries, the position throughout the engineering trades remaining much as I have reported for a considerable time past, and whilst there is no falling off in the exceptionally large quantity of both raw and manufactured material going into actual consumption, all indications point to the probability that these large requirements will be kept up for an indefinite period, certainly well over next year. In the face of this, the situation in the iron market during the past week has been somewhat perplexing. Prices in the open market have shown an unquestionable tendency to ease down, and merchants have been sellers at considerably under makers' quotations, whilst there is an evident disinclination at the present prices to hold more iron than is absolutely necessary. On the other hand, makers of pig iron are not only exceedingly strong at recent quotations, but have been further hardening up their list basis prices, and being heavily sold are not at all eager sellers, even where buyers are prepared to pay the maximum rates.

The irregular state of the market as regards prices, to which reference has already been made, tended to rather a quieter tone in business on Tuesday's 'Change meeting in Manchester. Local and district makers, however, reported that they were booking quite as much as they cared to do; as they are mostly fully booked for some time ahead, they are indifferent about further business just at present, and go on stiffening up in their quotations. For foundry brands Lancashire makers are quoting on the basis of 79s. 6d., less 2½, delivered Manchester. Lincolnshire makers have put up their minimum basis to 75s. 6d., and report that they are booking at 76s. 6d. net, whilst Derbyshire brands are nominally quoted at from 80s. to 82s. 6d. net, delivered Manchester. Forge qualities are equally strong, Lincolnshire makers having raised their minimum 1s., but they are still getting 1s. above even the advanced basis, sales having been put through at 75s. 2d. net, with Lancashire makers quoting 77s., less 2½, delivered Warrington. Both Scotch and Middlesbrough foundry brands are, however, now being offered by merchants in this district at prices relatively under those that Lincolnshire makers are asking; and as these brands are keen competitors, the question, if this continues, is whether makers will be able to permanently maintain the present position. The situation, however, is much the same with regard to makers' prices for Middlesbrough and Scotch, there being a margin of about 2s. between their quotations and those at which merchants have been prepared to sell. For delivery by rail Manchester, named foundry brands of Middlesbrough continue to be quoted at about 80s. 4d., with G.M.B.'s to be bought at 1s. to 2s. per ton less. For Eglinton and Glengarnock makers are quoting as high as 83s. 3d. net, delivered Manchester docks, whilst there have been sellers in the open market as low as 80s. 6d. to 81s. 6d. per ton.

The position in the finished iron trade shows no signs of any weakening, and some extraordinary prices are mentioned as got for special specification, as much as £9 17s. 6d. having, it is stated, been paid for Lancashire bars, delivered in this district. The minimum basis remains at £9 10s., and makers are not actually quoting above this figure in their regular trade. North Staffordshire bars remain nominally at £9 10s., but makers have practically withdrawn quotations on this basis. Sheets are firm at about £11, and hoops at £9 17s. 6d. for random to £10 2s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

The situation in the steel trade remains much as last reported, the tendency continuing strongly in a hardening direction. Hematites are not quoted under 90s. 6d. to 93s., less 2½ for No. 3 foundry. Local billets are firm at £7 net; ordinary basic steel bars, £9; common steel plates, £9 to £9 5s.; and boiler plates, about £9 12s. 6d., with hoops £10, delivered in this district.

The Manchester Merchants' Association has this week issued circulars notifying an advance of 10s. per ton in their stock prices for all descriptions of manufactured iron and steel.

Galloways, Limited, of Manchester, are sending to the Paris Exhibition six Galloway boilers, 30ft. by 8ft., for 160 lb. working pressure, and a vertical compound engine fitted with Corliss valves, to work in conjunction with a Mather and Platt dynamo, capable of developing 1600 ampères at 250 volts. These boilers and the engine, which have been selected by the British Commissions, will be in operation at the Exhibition, the former supplying steam and the latter generating electric current for the various purposes of the Exhibition. The firm has in hand for steel works' requirements a number of large vertical compound blowing engines and barometric condensers and pumps, together with a pair of exceptionally large three-cylinder reversing mill engines, and have received an order for haskanising plant for the Northern Wood Haskanising Company, Newcastle. Messrs. Galloway are also busily engaged on the contracts they have secured for the Salford and Liverpool electricity stations, to which I have previously made reference, and they are erecting four large boilers at the Stockton Corporation Electric Light Station.

The upward move in coal prices, to which I referred last week as more than probable, has with the close of the month been generally carried into effect. Although the full extent of the advance, so far as it relates to engine classes of fuel, has not been supported by the leading Manchester colliery firms, who are limiting their upward move to 10d. per ton on both round coal and engine fuel, the Lancashire Coal Sales Association, at a meeting held in Liverpool on Monday, decided to confirm their previous recommendation, that engine fuel should be advanced 1s. 8d. and round coal 10d. per ton, the only variation being that on unscreened coal the advance is to be 1s. 3d. per ton; and in accordance with this decision, notices to the above effect have been sent out by the various West Lancashire collieries. These advances in prices will bring the average pit quotations to about 13s. 4d. to 13s. 10d. best Wigan Arley; 11s. 8d. to 12s. 6d. Pemberton 4ft. and seconds Arley; 10s. 6d. to 11s. common round coal; 7s. to 7s. 6d. common slack; 8s. to 8s. 6d. good medium qualities; and 8s. 6d. up to 9s. 6d. for the very best qualities.

So far no opportunity has, of course, been afforded of ascertaining what effect this further advance will have upon the market. The house-fire coal trade is still only very moderate for the time of the year, and even the probability of higher prices has not stirred up the demand to any very appreciable extent, but collieries are in the position that they have little or no stock, and as soon as winter requirements do fairly set in there will be no difficulty in getting the maximum prices, with a possibility that any great pressure of demand may bring about an actual scarcity of supplies, and a still further upward move in list rates.

With regard to manufacturing classes of fuel a rather strong feeling is expressed by merchants, and certainly not less so amongst consumers, that the advance in slack is being pushed somewhat to an extreme, and that the prices now being demanded are placing a very heavy tax upon many important branches of industry. The position, however, is that collieries as a rule are absolutely short of supplies to meet present requirements, and in most cases for what little they have to offer beyond deliveries on contracts they are able to get special prices in the open market. It is, however, questionable whether, in the face of an advance of 10d. per ton by the leading Manchester firms, they will be able to maintain the full 1s. 8d. advance where they have to come into competition with slack offering in the Manchester district, but with general scarcity of slack there is scarcely likely to be any really serious competition in the open market.

The demand for shipment continues active, with a steady hardening up in prices, 12s. being now about an average figure for good ordinary qualities of steam coal delivered Mersey ports or Manchester Ship Canal.

Lancashire manufacturers have so far made no further official advance in their list quotations for coke, but are exceedingly strong at the maximum prices, and in many cases have to decline a considerable amount of business offering, as their present production is inadequate to meet the large requirements now coming upon the market. For good qualities of foundry coke the minimum quotation remains at 28s., with furnace cokes quoted from about 21s. to 22s. at the ovens.

Barrow.—The tone of the hematite pig iron trade in this district is very steady, and the demand from consumers is very fully maintained. Makers are exceedingly busy, but have little or no metal to dispose of for early delivery. They consequently are very firm in their quotations, and still ask 80s. for mixed Bessemer numbers, net, f.o.b., although the warrant market is depressed, owing to causes difficult to explain, except in relation to speculative movements. Warrant sellers quote 77s. 2d. net cash, and buyers 77s. 1d., and during the week some needy sellers have disposed of 4500 tons of their holdings, although better prices are assured even before Christmas. There is still on hand in warrant stores 211,690 tons, showing a decrease since the beginning of the year of 35,711 tons. Makers hold no stocks, and are, in fact, behindhand with their deliveries. There are 47 furnaces in blast, as compared with 40 in the corresponding week of last year. Prospects are considered very good in the iron trade, and both home and foreign buyers are pressing for deliveries.

Iron ore is in very full demand, and the yield from the mines in the district is below the requirements of the smelters, who are still compelled to buy largely from Spain and elsewhere. Prices are firm at 15s. for good average sorts, net at mines, with 19s. for best descriptions. Spanish ores are quoted at 18s. per ton, delivered at West Coast ports.

Steel makers are very fully employed, and are in receipt of very full order sheets. Railway material is very brisk, and prices are steady at £7 for heavy steel rails, and £7 15s. for light sections. Ship plates are quoted at £8, and there is a very good market. Billets, hoops, tin bars, sleepers, and heavy castings find a good market, and there is a brisk demand for nuts and bolts.

The shareholders of the Barrow Steel Company have decided to reduce the capital of the concern one-half, that is, by wiping off £764,000. At the meeting held in London on Friday, some opposition was shown by preferential shareholders, seeing that their shares are only preferential as to dividend, but the motion was carried with but six dissentients.

It is stated that the Barrow Steel Company has discovered another important vein of ore at Park Mines. This, if true, will be good news, as the company is at present in need of a good local supply of ore.

Shipbuilders and marine engineers are very busily employed, and are not likely to be short of work for a long time to come.

Coal and coke in full demand. Coke is now up at 34s. per ton delivered.

The shipping trade is very busy at West Coast ports. During last week 15,785 tons of pig iron and 9404 tons of steel were exported, being an increase of 1894 tons of pig iron and 3420 tons of steel, as compared with the corresponding week of last year. The total shipments to date this year are 478,050 tons of pig iron and 444,052 tons of steel, showing a decrease of 5002 tons of pig iron and 33,693 tons of steel, compared with the corresponding period of the previous year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE extraordinary mildness of the season has again affected the consumption of house coal, but the owners still expect to be able to make a further advance in prices on December 1st.

The demand for London is well maintained, as well as for the Eastern Counties and on local account. The request is still chiefly for secondary grades, but all qualities are called for. Best Silkstones are now 11s. to 11s. 6d. per ton; ordinary 10s. per ton; Barnsley house, 10s. 6d. to 11s. per ton; seconds from 9s. 6d. per ton. Nuts for household purposes fetch 8s. 6d. to 9s. 6d. per ton.

In steam coal the enormous quantities taken from South Wales has had the effect of making business much firmer in the more northerly coalfields. Although there is an urgent demand for all coal which can be brought to bank, the principal business is being done in the lower-priced qualities. The inland demand for the iron trade and the railway companies continues very brisk. Two of the railway companies are now endeavouring to arrange for next year's supplies, and the coalowners anticipate no difficulty in obtaining a smart advance.

The prices asked are 11s. for Barnsley hards, and 10s. for Parkgate hards, the quotations representing a difference of 2s. 6d. a ton on the contracts now expiring. The North-Eastern and Great Northern companies are both in the market for supplies; but the bulk of the contracts for locomotive fuel expire in the middle of the year. The steam coal current quotations are as follows:—Barnsley hards are 10s. to 10s. 6d. per ton, seconds from 9s. per ton. The gas companies are taking heavy deliveries of coal, which ranges from 8s. to 9s. per ton. Supplies of engine fuel are far short of requirements, the chief reason being the enormous weights taken for coking purposes. Nuts fetch from 8s. to 8s. 6d. per ton; screened slack from 6s. per ton; pit slack from 4s. 6d. per ton. Coke is easily saleable at from 19s. to 21s. per ton.

Iron and steel are as briskly called for as ever. Hematites have been unchanged during the week. Quotations at Sheffield: 94s. per ton for West Coast and 90s. per ton for East Coast; common forge iron, 72s. 6d. per ton; Lincolnshire No. 3 foundry, 75s. per ton; Derbyshire No. 3 foundry, 75s. per ton; steel billets from £7 to £10 per ton, according to quality.

NORTH OF ENGLAND.

(From our own Correspondent.)

A MORE satisfactory report can this week be given of the condition of the pig iron market than that which was printed last week, seeing that the business in warrants is no longer disorganised, and there is no longer a rush among speculators to sell out. It was recognised that the fall in warrant prices was caused solely by the operations of speculators, and was in no sense justified by any change for the worse—present or prospective—in the condition of the regular market. There was up to and including Monday last great pressure to sell warrants, but since that the market has been more favourable to producers, and prices have recovered a considerable part of the loss which they sustained last week. Naturally, though there was no real ground for any lower prices, legitimate business was much curtailed, in fact, was practically at a standstill, but since Tuesday a very fair business has been done, and Cleveland warrants, which dropped to 68s. 3½d. cash on Monday, have recovered until on Wednesday afternoon not less than 69s. 7d. would be taken. The ostensible reason given for the late drop in warrants was the dearness of money. It was said that some of the speculators in Scotch warrants did not see their way to continue to pay the high rates charged for "carrying over" warrants from one month to another—5d. per ton, or at the rate of 7½ per cent. per annum—and rather than again incur the charge they endeavoured to sell out before the close of this month. These weak holders have cleared out more quickly than was expected, and the downward movement did not continue till the end of the month, as many looked for.

Neither makers nor merchants allowed their prices to drop in proportion to the fall in warrants, and practically the quotations of the former have been stationary, so that on Monday they were more than 2s. 6d. above the price that was being offered for Cleveland warrants. Makers, indeed, are so well supplied with orders for execution next month and during the first quarter of next year, that they are practically independent of the market, and can ignore the fluctuations in warrants. It is ten years since they were in so satisfactory a position as that of the present. They have kept No. 3 Cleveland pig iron at 71s. per ton, which consumers have declined to pay; and as less would not be taken, the leading firms have, during the last two weeks, sold very little iron, though that does not trouble them. Merchants have sold at 70s., and even at 69s. 9d., but on Wednesday 70s. 6d. was their figure. Altogether the differences between the prices of sellers and buyers have been wide, which was not conducive to business. But the situation is more satisfactory at the time of writing than it has been, and more disposition is shown by consumers to buy. The lower qualities of Cleveland pig iron have not been disturbed by the fluctuations in the warrant market, and No. 4 foundry has been quoted and sold at 69s. 6d., with grey forge at 69s., and mottled at 68s. 6d.; indeed, in the early part of the week they were actually dearer than warrants, though these represent Nos. 1 and 3 qualities. There has naturally been a tendency to buy warrants when the consumer was not particular as to the brand that was supplied to him, and, besides, he could get prompter delivery of the warrants.

The general quotation for mixed numbers of East Coast hematite pig iron has been 82s. 6d. per ton, but consumers have not been prepared to pay that, and in the absence of business the value of hematite iron has been practically nominal. Rubio ore cannot be had under 20s. per ton delivered in this district. The Normanby Iron works Company, Limited, Middlesbrough, are about to build at their works a fourth blast furnace for the production of hematite pig iron. They are re-modelling their establishment also, from the designs of Hewson and Harrison, consulting engineers, Middlesbrough. The new blowing engines are being constructed by Sir Christopher Furness, Westgarth, and Co., Limited, engineers, Middlesbrough. In connection with these engines it has been decided to adopt American inlet and outlet valves for the blowing cylinder valves patented by the Southwark Foundry and Engineering Company, of Philadelphia. They have not hitherto been used in this country, but are said to be giving great satisfaction in the United States, not only for blast furnaces, but also for Bessemer converter blowing engines, pressures up to 15 lb. per square inch being commonly employed, and even 25 lb. can be attained without detrimentally affecting the efficiency of the apparatus. Before adopting the valve, Furness, Westgarth, and Co. sent over one of their leading officials to the States to examine the valves in regular operation. The Babcock and Wilcox patent tubular boilers are also to be adopted at this works.

Shipments of pig iron from the Cleveland district for November were very good, more especially during the last ten days of the month. The total quantity up to the 29th was 103,282 tons, as compared with 109,913 tons in October, and 76,580 tons in November, 1898. The stock of Cleveland pig iron in Connal's public warrant stores on the 29th was 74,612 tons, a decrease of 9868 tons for the month; the decrease during the latter part of the month being very rapid—almost 1000 tons per day. It is noteworthy that the stock is now smaller than it has been for two years, and much of the iron that has been taken out during the last fortnight has been shipped. The stock of hematite pig iron has been reduced 2285 tons during November to 29th, viz., to 10,668 tons.

The Chinese minister in Britain, his Excellency Chichen Lohfeng Luh, is, by command of the Emperor, engaged upon a report to the Chinese Government as to the industrial conditions of Great Britain, and with this object in view is visiting works in all the industrial centres of the country. This week he has visited Tees-side, and inspected at Middlesbrough the works of Messrs. Bolckow, Vaughan, and Co., and the North-Eastern Steel Company, and at Thornaby the bridge-building and engineering establishment of Head, Wrightson, and Co., Limited. At the Eston Steelworks his Excellency was informed that Messrs. Bolckow, Vaughan, and Co. employed over 14,000 workmen at their mines, collieries, manufacturing establishments, &c., and paid over £1,000,000 a year in wages. They raise annually 1,750,000 tons of coal, 2,000,000 tons of ironstone, and 220,000 tons of limestone, and they use also 450,000 tons of foreign ore. Their production of coke is 600,000 tons, while of pig iron 800,000 tons are made, of finished steel 300,000 tons, and of iron and steel castings 6000 tons.

The manufactured iron and steel industries are in all respects satisfactory, and have been altogether unaffected by the disorganisation of the warrant market. Works are in the fullest operation, and producers have no lack of orders for the first half of next year, so that prices continue to tend upwards, especially as buying is rather stimulated by the advances. Common iron bars are at £8 15s., best bars at £9 5s., iron and steel ship plates £8, iron and steel ship angles £7 15s., all less 2½ per cent., f.o.t. There are only two firms in this district who produce large iron plates for shipbuilding purposes, and as they have practically a monopoly they will not sell at less than the prices paid for steel.

The official statement issued to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England by their accountant, showing the extent of the deliveries and the average net price realised, is very satisfactory for the two months ending October 31st last. In fact, as regards prices there has not been a more favourable report forthcoming since the early part of 1890, and the deliveries are larger than in any two months for the last three years. The deliveries were 24 per cent. greater than those reported for the July-August period. The average realised price was £6 11s. 5·82d. per ton, this being 4s. 6d. above

the figure for the previous two months, 25s. more than was reported for the corresponding period of last year, and 37s. 4d. more than the lowest price ever reported; that being in June, 1895. As compared with the July-August period, rails advanced 5s. 5d. per ton; plates, 2s. 6d.; bars, 4s. 10d.; and angles, 6s. 3d.

Wages of finished ironworkers in the North of England are regulated by a sliding scale based upon these figures, and the above return gives them an advance of 3d. per ton on puddling and 2½ per cent. in other mill and forge rates, to commence from last Monday. The rate for puddling has risen this year 1s. 3d. per ton, viz., to 8s. 6d. per ton, while other wages have gone up 12½ per cent.

The death is announced at Barnard Castle, at the age of seventy-two years, of Mr. Henry King Spark, who for many years was prominently connected with the coal and iron trades of South Durham. He was born at Leeds, but early removed to Barnard Castle, where he was engaged in the printing business. Afterwards he settled in Darlington, and became a clerk in a colliery office, where he obtained that insight into the business of coal and coke agent which raised him afterwards to a position of affluence. He was at one time associated in business with Mr. Joseph Love, the well-known colliery owner in Durham. Mr. Spark was one of the promoters of the Merrybent and Middleton-Tyas Mining and Smelting Company, and also of a cognate scheme, the Merrybent Railway, which latter the North-Eastern Railway Company are now seeking power to take over. The deceased was interested in the Drinkfield Ironworks at Darlington, which being unsuccessful on its original lines, was converted into a co-operative concern, but has now disappeared, the works having been dismantled many years ago. Mr. Spark was also associated with the Carlter Ironworks, and the Darlington and District Banking Company. He was for a long time proprietor of the *Darlington and Stockton Times*, and thrice did he essay to represent Darlington in Parliament, but was each time unsuccessful.

The Newcastle Tramways Committee have decided to recommend to the Council the acceptance of the following tenders for plant:—Dick, Kerr, and Co., 5000 tons 45ft. steel rails at £8 7s. 6d. per ton, and fish-plates £9 17s. 6d.; Patent Nut and Bolt Company, 250 tons patent nuts and bolts, &c., £18 10s.

The Middlesbrough Corporation is about to make a trial of steel slag, *i.e.*, slag from the steel works, as a material for road-making purposes.

The new forge and engineering works for the Fownes Forge and Engineering Company, at Jarrow-on-Tyne, were opened a few days ago. The main shop is 400ft. long by 40ft. span, and is served by a 25-ton electric travelling crane, which runs the whole length of the shop and also over the wharf, so that a shaft made at the top end of the shop can in a few minutes be loaded either on to the railway trucks or a craft in the river. The smithy is 200ft. long by 30ft. span. In another branch, served also by an electric crane, will be a 10-ton hammer and a 3500-ton hydraulic forging press.

The coal trade continues very active; indeed, it has not for many years been so brisk, and prices all tend upward, 14s., f.o.b., being now asked for best steam coal, 8s. for steam smalls, 14s. for best gas coals, and 13s. 6d. for bunkers. Inquiries are very numerous for coking coal and coke, especially from abroad. Best foundry coke has been sold at 28s. 6d. per ton, f.o.b., and best blast furnace coke at 25s. for next half-year; but medium coke can be got at 23s. at the furnaces.

At the Broom Mill Colliery a fire has occurred which destroyed the headstead, doing damage to the extent of £20,000. The output of steam coal in Northumberland will be reduced 1300 tons weekly by this mishap.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron market has this week lacked the strength that recently characterised it. The trade position is considered to be quite sound, and there is a large demand for raw iron. An impression has, however, got abroad that, especially as regards the American business, prices have realised about the highest point; this has led to a good deal of selling on the Glasgow warrant market, and the orders to sell have come largely from London. The position of the market is altogether difficult to forecast. Higher prices might again be seen before long. Business has been done this week in Scotch warrants from 70s. 7½d. to 69s. 7½d., improving again to 70s. 10d. cash; and from 71s. to 70s. 0½d., improving to 71s. 4d. one month. The transactions in Cumberland hematite warrants have varied from 77s. 3d. to 78s. cash, and 77s. 10d. to 78s. 5d. one month. Cleveland iron has sold at 68s. 9d. cash, 68s. 7½d. seven days, and 68s. 9d. to 70s. one month.

Since last report an additional furnace has been put on blast at Glengarnock Iron and Steel Works to produce basic iron. There are now 83 furnaces blowing in Scotland compared with 82 at this time last year, and of the total 40 are producing hematite, 38 ordinary, and five basic iron.

There is a large consumption of Scotch-made hematite pigs at the steel works, and merchants are quoting for this class of iron 86s. per ton for delivery at the steel works.

The makers of ordinary pig iron and special brands have had their resources taxed to the utmost to overtake their engagements for delivery. Within the last day or two they have been declining to accept orders for delivery at fixed dates, only undertaking to supply the iron as circumstances will admit. A very long time has elapsed since such a state of matters was possible. Not only is the entire output of the furnaces absorbed at once, but increasingly large inroads are being made on stocks. The stock in Connal and Co.'s Glasgow stores has been reduced during the past week by 4826 tons.

The prices of makers' iron, except warrants, which are ruled by the warrant market, are firm. Govan, No. 1 is quoted f.o.b. at Glasgow, 72s.; No. 3, 71s.; Carnbroe and Wishaw, Nos. 1, 80s.; Nos. 3, 77s.; Clyde, No. 1, 84s.; No. 3, 79s.; Garsherrie, Summerlee, and Calder, Nos. 1, 85s.; Nos. 3, 80s.; Coltness, No. 1, 89s.; No. 3, 81s.; Glengarnock at Ardrossan, No. 1, 83s. 6d.; No. 3, 78s.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, No. 1, 80s.; No. 3, 78s.; Shotts at Leith, No. 1, 85s.; No. 3, 80s.; Carron at Grangemouth, No. 1, 87s. 6d.; No. 3, 81s. per ton.

The shipments of pig iron from Scottish ports in the past week have amounted to 6214 tons, compared with 4613 in the corresponding week of last year. There was despatched to Canada 186 tons, India 164, Australia 200, France 360, Italy 220, Germany 118, Russia 40, Holland 1320, Belgium 40, Spain and Portugal 130, China and Japan 250, other countries 50, the coastwise shipments being 3136, compared with 2690 tons in the same week of 1898.

The finished iron and steel trades continue well supplied with orders, and business is reported to be done without difficulty at the recent advanced prices.

The coal trade is extremely busy. There is a very pressing demand both for home use and export. The current shipments show a slight falling off, but the inquiry is such as to indicate that very large quantities will be despatched in succeeding weeks. The prices that are charged at Cardiff and Newcastle are relatively so much higher than those prevailing in the Clyde, that increasing business is going to the latter. Many of the coal-masters have orders on their books that will tax all their resources for weeks to come. The result of this has been a further general advance in prices of about 6d. per ton. Main coal is quoted f.o.b. at Glasgow, 10s. to 10s. 3d.; ell, 11s. to 11s. 6d.; steam, 11s. 6d. to 11s. 9d.; splint, 11s. 6d. to 12s. per ton. The demand for household coals has not been quite so pressing, owing to very mild weather.

During November 38,834 tons of new shipping has been launched from the Clyde shipyards, compared with 31,039 in the same month of 1898. The aggregate tonnage launched for the past eleven months is the largest on record, amounting to 406,771 tons, compared with 372,807 in the corresponding period of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THOROUGH animation characterises all principal coal and iron shares. This week Ebbw Vales have been done freely at between £10 14s. 6d. and £11; Norths, Ordinary, between 5¼ and 55·22. Some business has been done in Rhymney Iron, Old, at 45s. 6d. and 46s. 9d., in the New at 31, and in Tredegar Iron A at 73s. 6d. Davis's Ordinary have improved ¼; Ebbw Vales, 5·15; and Newport, Abercarn, Ordinary, ¾. Railway stock is not so brisk as one would expect, and several dropped a point this week. This is, perhaps, due to the wage and hour agitation prevailing.

Colliery enterprise is shown in many quarters, all coals being in exceptionally good demand, house coal, the semi-bituminous of Monmouthshire, best and second steams, and the anthracite of the Swansea and Llanelly districts. At Bridgend there is a colliery development, and a syndicate of Cardiff capitalists are about working the seam at Heolaethog. Ballard Colliery, Blackmill, is in full swing, and others are to follow. The South Crop mineral rights, formerly belonging to and worked by the Barrow Company, are now being worked by Mr. J. Lewis, of London, formerly of Bridgend. At Swansea a company has been formed to sink a pit at Trebooth, near Swansea. Sinking has begun. In January the Cefngyfelach Company will sink at Llangyfelach.

In coke there is the fullest vigour, as can be seen by the night and day working in all direction, and the crowded railway sidings in connection with all the industries, and especially steel works. Last week a fine range of copper ovens was started at Tondu. These were erected for North Navigation, and it is estimated when all is complete will cost £20,000.

Last week there was a large export of coal from all ports. Swansea made a stroke of 15,000 tons over late despatches, and Cardiff and Newport sent a full average. Swansea, as usual, sent nearly half of its coal exports to France. Port Said, Aden, and Gibraltar are being strongly supplied by Cardiff.

There is a steadily increasing demand for house coal, and as steady an advance in price. Small steams are slightly lower consequent upon an abundant supply. This is regarded as only temporary.

Closing coal prices this week at Cardiff were as follows: Best steam, 20s. to 21s.; seconds, 18s. 6d. to 19s.; drys, 18s. to 18s. 6d.; best Monmouthshire, 17s. 6d. 18s.; seconds, 16s. to 16s. 6d.; best steam smalls, 11s. to 11s. 6d.; seconds, 10s. to 10s. 9d.; best households, 16s. to 17s.; No. 3 Rhondda, 18s. 6d. to 19s.; brush, 14s. 6d. to 15s.; small, 12s. to 12s. 6d.; No. 2 Rhondda, 15s. 6d. to 16s.; through and through, 12s. to 12s. 6d.; small, 9s. to 9s. 6d.

Swansea prices:—Anthacite, 15s. to 16s.; seconds, 13s. 6d. to 14s. 6d.; ordinary large, 11s. 6d. to 12s. 6d.; small rubbly culm, 5s. 9d. to 6s. 3d.; steam, 18s. to 20s.; seconds, 16s. to 17s.; bunkers, 11s. to 11s. 6d.; small, 9s. to 9s. 6d.; bituminous, according to arrangement.

Patent fuel is advancing in harmony with coal prices. Cardiff figures are now 18s. to 20s.; Swansea, 15s. 6d. to 16s. 6d. Coke is also in the ascending scale. Cardiff prices are 26s. to 28s. for furnace; foundry, 29s. to 30s.; and special foundry, 35s.

Pitwood, Cardiff, 20s. to 20s. 6d. Iron ore, 17s. to 18s. 6d.; Swansea the same. All colliery and works requirements are in sympathy, and on the up grade.

In all directions evidence is given of the steel boom. In the Swansea Valley the gas producers at the Milbrook Works, which have been out for six months, were lit up, and one of the furnaces is to be started smelting forthwith.

There has been again a good deal of pig iron gambling, and the warrant market has fluctuated, showing a reduction of 1s. 10d. per ton in Scotch, 1s. 1d. in Middlesbrough, and 1s. 6d. in hematite. On 'Change this week, Swansea, this was emphatically stated to be due to speculation, and not regular trade, as this gave no justification. Makers retain quotations unchanged. Consumers are stated to have bought warrants, instead of going to the furnaces for iron; but an authority says that it is a speculative course, and not found to answer. Finished iron and steel are both reported to be in full demand, with still advancing prices, and extreme difficulty found in getting deliveries. Almost impossible to arrange forward sales, and everything tending upward.

Latest Swansea prices: Glasgow pig iron warrants, 69s. 7½d. to 69s. 9d. cash buyers; Middlesbrough No. 3, 68s. 10½d.; other numbers in proportion; hematite warrants, 76s. 9d. for mixed numbers; Cumberland according to brand; Welsh hematite, 82s. 6d.; Welsh bars, £9 to £9 10s.; angles, &c., at usual extras; sheet iron and steel, £9 15s. to £10; Bessemer steel tin-plate bars, £6 10s.; Siemens, £6 12s. 6d.; steel rails, heavy, £7 10s. to £7 15s.; light, £8 10s. to £9.

Tin-plates: Bessemer steel cokes, 15s. 6d. to 15s. 9d.; Siemens, 15s. 9d. to 16s. In the Liverpool market size 14 by 20 I.C. is stated to have been done at 15s. 1½d. Wales, 15s. 6d. Liverpool. Ternes, per double box, 28 by 20 C, 28s., 29s., to 35s.; best charcoal, 16s. to 17s. 6d. Big sheets for galvanising, 6ft. by 3ft. by 30 G., per ton £14 15s. to £15. Finished black plate, £12 10s. to £12 15s. Canadas, £10 10s. to £11. Galvanised sheets, 24 g., £14 5s. to £14 10s. Block tin, £124 17s. 6d. to £124 15s. Spelter, £20 2s. 6d. Lead, £17 10s. Copper, Chili bars, £75 to £72 15s. Liverpool prices forward are given as £73 15s.

The recent reductions in block tin do not appear to have made any difference in the cost of production, as nearly all makers are covered for their requirements for months to come; and as stated on 'Change, there are very few who can at once turn to the lower prices. The tone of trade is good. Last week 52,261 boxes were brought from works; shipments, 48,121 boxes; present stock, 145,441 boxes.

I note that Ystalyfera Iron and Tin-plate Works will come to the hammer next week; these are near Swansea. Holland is a large buyer at Briton Ferry of its hematite.

All foundries and engineering works are busy. Chemical factories, Landore, Llansamlet, Morriston, and Portardawe exceptionally brisk.

The railway men on the Taff Vale, Rhymney, Cardiff, and Barry railways are continuing their agitation for a change in hours of labour and wages. On the Cambrian the cleaners at Oswestry to the number of forty came out on account of some little friction in the locomotive department.

The Bwllfa and Nantmelyn men, Aberdare Valley, have been called upon by the company to sign the Nos. 2 and 3 books. Some trouble is anticipated.

The Cardiff Corporation Bill for the coming session is now published. It is for an important extension of tramways. The Taff Vale will apply for powers for junction lines in Radyr, and for time extension Taff Vale Act, 1897.

The new dry dock at Barry, which has been in construction by Messrs. Price and Wills, contractors, is now practically complete, and promises to be an important addition to ship-repairing in that quarter. The new dock will admit a steamer 620ft., and as I remarked some time ago, is so constructed that it may be used as a double dock, affording room for two vessels 304ft., and two 316ft. respectively. This permits the company to dry dock eight large steamers at the same time. At high-water spring tides the depth of water inside is 27ft. 9in., and at high-water neap tides 19ft. 3in. It is 65ft. in breadth. At the entrance to the dock is a large floating caisson supported by strong iron tanks. The builders were R. Stephenson, of Newcastle-on-Tyne. The dock was designed by Sir J. Wolfe Barry, K.C.B. Work of construction was begun in 1896.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE position of the iron market over here does not show any change upon the week; in all branches of the iron and allied trades employment has been active and satisfactory as before. With regard to prospects for next year, the belief is that activity and demand will be as good then as they are now, and some think an increase may even be felt in spring and early summer. Iron ore sells well, and the business in raw iron shows remarkable briskness. The scarcity in all sorts of pig iron, which is the cause of so much trouble and delay, will doubtless increase next year, if the occupation in the manufacturing branches is as lively as it promises to be; and unless production in pig iron is considerably raised, there is sure to be a further advance in prices. In October of present year, output of pig iron in Germany, including Luxemburg, is officially stated to have been 691,266 t., of which 134,174 t. were forge pig and spiegeleisen, 49,130 t. Bessemer, 387,076 t. basic, and 120,886 t. foundry pig. Production in September of present year was 661,068 t.; in October last year 651,122 t. were produced. From January 1st to October 31st of present year, 6,719,843 t. pig iron were produced, against 6,101,717 t. for the corresponding period in the year before.

The steel makers are enjoying a brisk trade. The demand for plates and sheets is very strong, and hoops have been in increasing request, foreign inquiries being numerous; M. 195 p.t. is the price now generally quoted. The bar and girder trade shows marked steadiness, though this is the time when an abatement in activity is usually noticeable in these branches. Shipbuilders and engineers, and the shops engaged in the production of railway rolling stock, are very busy.

The German coal trade is in as good a position as the iron market. Consumption is heavier than output, as a rule, and that prices are very stiff, with a rising inclination, is a matter of course. Coal for coke-making is in particularly good request.

Though there is rather a languid tone prevailing in many departments of the Austro-Hungarian iron industry, there are still a few branches that can be reported in steady, though not very brisk, employment. The machine and wagon shops, for instance, are busily occupied, and, being well booked forward, need not feel any uneasiness with regard to employment in the future.

Coal for industrial purposes is firm in price, and briskly called for in Austria-Hungary, and though house coal was only moderately inquired for until now, owing to the exceptionally mild weather, the tone of the market generally is healthy and satisfactory. Official quotations are the same as before, but in a few instances slight advances were put on engine coal.

Belgian iron masters are doing a sound and satisfactory trade. The volume of business in all departments is very great, and promises to increase rather than otherwise. The steel trades are particularly active, and it is very difficult to obtain delivery of materials in the time specified; foundries and locomotive works are all very well employed, and numerous contracts have been secured for iron and steel goods for structural purposes.

In France the market for iron and steel has, likewise, remained very lively; the demand for pig iron is large and in excess of supply, and a very good business is done in manufactured iron and in steel. Makers have their order books well filled, and as they are being offered more work than they can undertake or care for in many cases, prices are in their hands, and so for early deliveries they easily get higher rates.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal keeps in good demand, with prices same as last week. House coal in good request, and prices firm. Steel and iron works fully employed, and prices advancing for steel bars. Exports for week ending November 25th were:—Coal: Foreign, 53,869 tons; coastwise, 22,959 tons; patent fuel, 1895. Imports for week ending November 28th were:—Iron ore, 9194 tons; copper pyrites, 25,002; scrap iron, 490; steel scrap, 130 tons; pig iron, 2550; cement, 210 tons; pitwood, 4085 loads; one cargo deals.

Coal: Best steam, 17s. 6d. to 18s.; seconds, 16s. 6d. to 16s. 9d.; house coal, best, 15s.; dock screenings, 10s. 6d.; colliery small, 9s. 6d. to 10s.; smiths' coal, 10s. 6d. Pig iron: Scotch warrants, 70s. 10d.; hematite warrants, 77s. 11d. f.o.b., Cumberland; Middlesbrough, No. 3, 69s. 6d. prompt. Iron ore: Rubio, 19s. to 19s. 3d.; Tafna, 17s. 6d. to 18s. Steel: Rails—heavy sections—£7 10s. to £7 15s.; light do., £8 10s. to £9, f.o.b.; Bessemer steel tin-plate bars, £6 10s.; Siemens steel tin-plate bars, £6 12s. 6d. to £6 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 15s. 6d. to 15s. 9d.; Siemens—coke finish—15s. 9d. to 16s. Pitwood: 18s. 6d. London Exchange Telegram: Copper, £75; Straits tin, £127 5s. Freights, steady.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 22nd.

THE Naval Board of Construction has decided to ask Congress to authorise the construction of three armoured cruisers, three protected cruisers, and twelve light draught gunboats. The three armoured cruisers will exceed in tonnage the largest vessels in our navy, and will be larger than any armoured cruisers in the British Navy, and have 2000 tons greater displacement than any battleship now under construction in our shipyards. The guns will be 12in., the 13in. gun having been abandoned. The Society of Naval Architects held a conference on November 17th, at which papers were read. The shipyard combine is not making much progress. New York will soon enter upon some big engineering enterprises, viz., the construction of a bridge, also of a tunnel. The need of more rapid transit is imperative, and the only way to get up and down town quickly is to go through a hole in the ground. Several million dollars are soon to be spent in equipping the elevated system with electricity. Companies are still multiplying for manufacturing and commercial purposes. The basis of the present extraordinary activity is the requirements of railroads. Shipbuilders are also large buyers of material. The electrical requirements are extraordinary. Cities and towns all over the country are bonding themselves for money for public improvements. The steel makers could afford to shut their offices for three months. Prices are still pointing upward, and further advances are probable, despite the large amount of material purchased for forward delivery. Pig iron output will soon be 300,000 tons per week.

TRADE AND BUSINESS ANNOUNCEMENTS.—On and after the 1st December the London office address of John Brown and Co., Limited, will be 25, Victoria-street, Westminster, S.W.

THE INSTITUTION OF ELECTRICAL ENGINEERS AT THE PARIS EXHIBITION.—It is proposed to hold a meeting of the Institution of Electrical Engineers in Paris immediately before the opening of the International Electrical Congress, and probably on the 16th, or 16th and 17th, of August, 1900. It is further hoped that a joint meeting with the American Institute of Electrical Engineers may be arranged at that time. In order that a preliminary estimate may be formed of the number of members of all classes who will take part, the Council would be glad to receive at an early date the names of those who think it likely that they may attend.—The annual dinner of the Institution of Electrical Engineers will be held at the Hotel Cecil on Wednesday next, December 6th, and application for tickets not yet submitted should be sent in at once.

LONG RAILS AND MITRE-CUT RAIL ENDS.

AT the annual meeting of the Roadmasters' Association of America, which is the equivalent of an association of inspectors of maintenance of way, a Committee report was presented on the use of rails longer than 30ft., and on the cutting of rail ends diagonally instead of squarely across the rail. The following is the substance of the report:—About eight railroads in the United States have purchased and are using 45ft. and 60ft. rails. The use of rails over 30ft. in length was commenced experimentally about nine years ago, and while results in some instances have proved quite satisfactory, it may be said that not enough time has yet elapsed to fully develop either the advantages or disadvantages. The advantages claimed for the 60ft. rails are the reduction of 50 per cent. in the number of joints, better riding track, and one maintained with less labour. From information gathered it appears that the objections to 60ft. rails are—First, that they are not properly straightened at the rolling mills. While this would seem to be a question of mechanical skill, yet the complaint is general, and indicates that the mills are not prepared and are unable to straighten 45ft. or 60ft. rails as well as the 30ft. rails. Secondly, complaints are made by track men that more labour is required on 60ft. rails, in order to secure good surface, than on the same length of track laid with 30ft. rails; this on account of rails springing and not rising to a uniform surface. Thirdly, another objection offered is the increased opening required to allow for expansion.

It is claimed by many track men that not to exceed 50 per cent. more expansion is required for 60ft. rails than for 30ft. rails, but as few roads have used less than 50 per cent. with satisfactory results, and not having been able to establish the fact scientifically, your Committee cannot vouch for its truth.

Inquiries at the leading rolling mills in this country reveal one or two significant facts, namely, that rails 45ft. and 60ft. in length have not yet proved satisfactory, or that purchasers are still watching the results, as few roads have placed a second order for such rails. Until a more perfect workmanship can be attained in the straightening of 45ft. and 60ft. rails they are not likely to be favourably received, however satisfactory they may be in other particulars. The subject is one that should receive continued investigation, as the introduction of any means by which 50 per cent. of rail joints can be successfully reduced will be a boon to railroads generally.

After careful consideration your Committee can see no objections to 33ft. rails, and would recommend their use. The advantages to be obtained are, greater convenience in handling, transporting and maintaining, and a reduction of 10 per cent. in joints. We have strong hope that further trial and improvement in manufacture and appliances may at no distant day render it practicable to recommend 45ft. and even 60ft. rails.

From present information we cannot recommend mitre-cut rails. The point of contact between wheel and rail is so slight that an opening at any practicable angle will cause a blow, and as the mitred points are unsupported by the web of the rail, we believe that the depression or flattening at the joints will be about as rapid as the square-cut rails.

Evidence from two prominent roads where mitred rails cut at an angle of 55 deg. have been in hard service for four and five years, show fairly satisfactory results. Other roads, after nine years' trial, are not placing any orders for mitred rails. We are satisfied, from information gathered, that in some instances, at least, the unsatisfactory condition of the rails has been caused by too great expansion space having been allowed.

LAUNCHES AND TRIAL TRIPS.

MACEDONIA, steel screw steamer; built by, Craig, Taylor, and Co.; to the order of, A. C. de Freitas, of Hamburg; dimensions, 274ft., 35ft., 23ft. 8in. moulded; engines, triple-expansion, 22in., 35in., 59in., by 39in. stroke, pressure 160 lb.; constructed by, Thomas Richardson and Sons, Limited; strengthened for ice; launch, November 18th.

DON HUGO; built by, David J. Dunlop and Co.; dimensions, 310ft., 38ft., 20ft. 6in. moulded to main deck; engines, triple-expansion, 24in., 40in., and 66in., by 48in. stroke, pressure 180 lb.; loaded with 2500 tons deadweight; attained speed of 13 knots; trial trips, November 14th and 15th.

DEVOLANT, large loading dredger; built by, Wm. Simons and Co., Limited, Renfrew; to the order of, the Russian Government; engines, compound; constructed by, builders; compound engines work dredgers of sufficient power to dredge 2000 tons per hour. The buckets each hold 35 cubic feet. Launch, complete with engines, and ready for work, on November 22nd.

ETRURIA, spar-deck steamer; built by, Craig, Taylor, and Co.; to the order of, A. de Freitas and Co., of Hamburg; dimensions, 274ft., 35ft., 23ft. 8in. moulded; engines, triple-expansion, 22in., 35in., 59in., by 39in. stroke, pressure 160 lb.; constructed by, J. Richardson and Sons; masts suitable for Manchester Ship Canal requirements; trial trip, November 23rd, 12½ knots against strong wind and tide.

HANOVER, steel screw steamer; built by, Wigham Richardson and Co.; to the order of, North German Lloyd Company, of Bremen; dimensions, 455ft., 54ft., 27ft.; engines, quadruple, Y. S. and T. system, 19in., 26½in., 40½in., and 59in., by 42in.; trial trip, November 25th.

NEW COMPANY.—The prospectus of the Electrolytic Alkali Company, Limited, is before the public. Its capital is to be £500,000, divided into 200,000 7 per cent. cumulative preference shares—preferential both as to capital and dividend—of £1 each, and 300,000 ordinary shares at £1 each. The present issue is £300,000.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

16th November, 1899.

22,833. PROP for SUPPORTING BICYCLES, C. Maule, Ely.
22,834. BURNERS, G. W. Sutton and J. H. H. Rolfe, London.
22,835. BICYCLES, W. G. Dickson, Guernsey.
22,836. ACETYLENE PORTABLE LIGHT, W. Cheeseman, London.
22,837. HAT-PINS, F. J. Hibberd, Dundee.
22,838. GAS ENGINES, J. E. Thornton and C. F. S. Rothwell, Altrincham.
22,839. BEVERAGE PREPARATION, T. Littlehales and E. J. T. Digby, Birmingham.
22,840. RIM BRAKES for CYCLES, R. F. Hall, Birmingham
22,841. CONSUMING SMOKE in FURNACES, W. Fowler, Bradford.
22,842. LEATHER LACE MACHINES, W. Davidson, Leicester.
22,843. WATER-TUBE BOILERS, W. D. Hamilton, Glasgow
22,844. SOCKETS for TUBULAR JOINTS, J. Birtwisle, Manchester.
22,845. FLUSHING SYPHONS, W. E. Mason and C. Heath, Manchester.
22,846. VARIABLE-SPEED GEAR for MOTOR CARS, G. H. Handasyde, Edinburgh.
22,847. WICK WINDERS for OIL LAMPS, A. E. Hancock, Birmingham.
22,848. DRAIN-TESTING APPARATUS, W. Jameson, Birmingham
22,849. STOP VALVES, A. Fulton, Glasgow.
22,850. CORN SHEAF BINDING NEEDLE, A. Park, Glasgow.
22,851. PUSH JOINT for TOBACCO PIPES, J. G. Blatter, London.
22,852 PULLEY BLOCKS, E. Allday and W. T. Eades, Birmingham.
22,853. ELECTRO-MAGNETIC COILS, J. Jones, Dundee.
22,854 MECHANISM of BRAKES for CYCLES, C. Owen, London.
22 855. CYCLE and other DRIVING CHAINS, J. Hadley, London.
22,856 CYCLES, G. Gibson, Liverpool.
22,857. LIGHT-CURVATURE APPARATUS, L. Cunow, Birmingham.
22,858. BRAKES for BICYCLES, The New Rock Cycle Manufacturing Company, Ltd., and S. F. Hannah, Sheffield.
22,859. THE TRANSVAAL WAR GAME, P. Layton, London.
22,860. EASEL, H. W. Roberts, Newmarket.
22,861. BICYCLES, M. Pedersen, Dursley, Glos.
22 862. GERM DESTROYER, C. M. Johnson, Redhill, Surrey.
22,863. MODE of CARRYING or FLYING a WEIGHT or BODY for SCENIC EFFECTS. G. C. Vaughan, London.
22 864. SIGNAL APPARATUS, H. Conduit and G. C. Janeway, London.
22,865. LIQUID DISTRIBUTION, W. D. Scott-Moncrieff, London.
22,866. NEW PUZZLE or GAME, G. Kerr, jun., London.
22,867 TREATING SURFACES of CELLULOID, A. N. Petit, London.
22,868. BICYCLE MECHANISM, A. Rigg and W. I. Thomas, London.
22,869. SPANNERS, J. E. Grivel, Paris.
22,870. BOOT, R. Devereux - Knowles, Richmond, Surrey.
22,871. CLUTCHES, J. W. Adams, London.
22,872. REINS, J. Golledge, London.
22,873. BOTTLE STOPPERS, W. F. Dahlmann, London.
22,874. CAN OPENERS or METAL CUTTERS, F. Müschenborn, London.
22,875. MATTRESSES, L. Kippenhan, London.
22,876. PENCILS, C. Engelhardt, London.
22,877. SAW-CUTTING APPARATUS, &c., E. Seelig, London.
22,878. CYCLE-HEAD LOCKS, Clark Brothers Cycle Company, Limited, and T. W. Moore, London.
22,879. CELLULOSE ARTICLES, E. G. P. Thomas.—(*J. Bonavita, France*)
22,880. CELLULOSE ARTICLES, E. G. P. Thomas.—(*J. Bonavita, France*)
22,881. SHIPS' PROPELLERS, C. V. Suppan and B. Szendi, London.
22,882. VELOCIPEDE-DRIVING GEAR, W. F. Cave, Coventry.
22,883. MOTORS, J. Ridley and J. W. Roebuck, Caventry.
22,884. CEILINGS and WALLS for BUILDINGS, F. Kemnitz, London.
22,885. RUNNING VEHICLES on ROAD RAILS, E. Monteils, London.
22,886. MANUFACTURE of COLOURING MATTERS, H. H. Lake.—(*Chemical Works, formerly Sandoz, Switzerland.*)
22,887. TRUCK COUPLINGS, E. A. Maund and J. Smith, London.
22,888. CYCLE GEAR, A. W. Rider. London.
22,889. TROLLEYS, W. R. Ormandy and J. Unsworth, Liverpool.
22,890. LADDERS, M Barth, Liverpool.
22,891. POSTAL WRAPPER or LETTER-CARD, H. Moser, Liverpool.
22,892. MACHINES for BOOKBINDING, J. Meek, Liverpool.
22,893. CUTTER HEADS or STOCKS, R. Perrin, Liverpool.
22,894. TREATING PAPER BOARD, J. B. Bourseau, London.
22,895. SCREW FASTENER for DOORS, J. B. Podmore, Cowfold, Sussex.
22,896. CYCLE ALARM, A. H. Godfrey, Birmingham.
22,897. OIL LAMPS, S. J. Whitbread, London.
22,898. FEED-WATER FILTERS, I. S. McDougall and N. N Haigh, London.
22,899. LOOMS, J. Charpenel, London.
22,900. MAGNETIC CUT-OUT APPARATUS, L. Andrews, London.
22,901. MACHINE for PEELING POTATOES, J. Blache, London.
22,902. PNEUMATIC DRILLS, H. J. Kimman, London.
22,903. PROPULSION MECHANISM, L. Cerebotani and C. Moradelli, London.
22,904. CUTTING LOCK SPRINGS, P. Olmesdahl, London.
22,905. WHEEL TIRES, H. Loog and R. R. Gubbins, London.
22,906. CLINICAL THERMOMETERS, J. J. Hicks, London.
22,907. DOOR LOCKS, F. J. J. Gibbons, London.
22,908. STRENGTHENING FINGER RINGS, J. J. Bohr, London.
22,909. SHOVELS, C. W. Allen, London.
22,910. STAND for DISPLAYING PHOTOGRAPHS, G. Wright, London.
22,911. ELASTIC CYCLE BEARINGS, F. Schmitz, London.
22,912. CYCLE GEAR, C. F. Renard and L. E. Landry, London.
22,913. FRICTION CLUTCHES, J. J. B. Arter, Birmingham.
22,914. FRICTION CLUTCHES, J. J. B. Arter, Birmingham.
22,915. FRICTION CLUTCHES, J. J. B. Arter, Birmingham.

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22,916. COMBINED OIL DIFFUSER, H. J. Lock, Gosport, Hants.
22,917. OIL LAMPS, R. Hyatt and B. H. Thwaite, London.
22 918. LETTER BOX and NAME PLATE, J. Riley, Southampton.
22,919. MAKING ELECTRIC INSULATORS, S. W. Johnson, Sheffield.
22,920. BRAKE MECHANISM for CYCLES, W. E. Poole, Birmingham.
22,921. A PHONO-TYPEWRITER, W. H. Turner, Birmingham.
22,922. TENSION LOCK JOINT, J. Anderson, Newcastle-on-Tyne.
22,923. KILNS for DRYING CEREALS, J. Duncan, London.
22,224. PHOTO and PICTURE FRAME, C. Averbook, London.
22,925. APPARATUS for SHOEING HORSES, A. Jagger, Halifax.
22,926 PREVENTING DOWN-DRAUGHTS in CHIMNEYS, J. J. Green, Halifax.
22,927. KILNS for DYEING PURPOSES, W. W. L. Lishman, T. W. Haughton, J. J. Kirkpatrick, and the Lishman Process Bleaching Company, Ltd., Halifax.
22 928. APPLIANCE for DISTILLING WATER, A. Deane, Glasgow.
22 929. REVERSIBLE INGOT MOULD, J. Hart, Middlesbrough.
22,930. COMPOUND AIR ENGINE, J. Dobson.—(*F. R. Dobson, Canada.*)
22,931. ROTARY PUMP, A. Peter, Glasgow.
22,932. MACHINE for BENDING CHAIN LINKS, H. Spühl, Manchester.
22,933. ACCOUNT FORM and WRAPPER, A. A. Liversidge, Winchcomb Gloucester.
22,934. TREATING YARN, W. Bleakley, T. Polli t, H. T. R. Stuart, and W. Simpson, Manchester.
22,935. LEAF TURNERS, J. Wize, Glasgow.
22,936. VELOCIPEDES, J. V. Pugh. London.
22,937. KETTLE, C. S. Meacham, London.
22,938. SLIDES for BORING MACHINES, R. and W. B. Lang, Glasgow.
22,939. GEAR-CASES for CYCLES, C. M. Linley, London.
22 940 MOTORS for TOOLS, C B. Albree, Liverpool.
22,941. MOTORS and TOOLS for STAMPS, C. B. Albree, Liverpool
22,942. STEERING GEAR for MOTOR VEHICLES, A. Craig, Coventry.
22,943. IGNITION TIMING GEAR for ENGINES, A. Craig, Coventry.
22,944. COLOURING MATTERS, Read, Holliday, and Sons, Limited, J. Turner, H. Dean, and J. Turner, London.
22 945. HANSOM CAB PROP, J. Wilson, London.
22 946. CARD MARKER, H. F Brown, London.
22,947. FRONT FORKS for BICYCLES, H. Stanbridge, Twickenham, Middlesex.
22,948. DYEING and WASHING APPARATUS, P. Schirp, Barmen, Germany.
22,949. CUFF for CYCLISTS' TROUSERS, H. Pelman, Cologne-Lidenthal, Germany.
22,950. BOOT and SHOE LACE, H. M. Stephens, Beckenham, Kent.
22,951. VELOCIPEDES, E. H. Hodgkinson, London.
22,952. MACHINE for CUTTING UP RAGS, A. R. McLellan, London.
22,953. CLEARING WINDOWS from MOISTURE, W. R. K. Gandell, London.
22,954. KINEMATOGRAPHS, L. E. Granichstaedten, London.
22,955. RAILWAY VEHICLE COUPLINGS, H. T. Davidge, London.
22,956. PHOTOGRAPH FRAMES, S. Hockly, London.
22,957. FASTENINGS for LAVATORIES, W. R. Baker, Wallington, Surrey.
22,958. TRANSMITTING POWER ROUND ANGLES, H. Balfour, London.
22,959. SEATS for VEHICLES, N. Boyer and B. Demont, London.
22,960 ELECTRIC INSULATING DEVICES, H. H. Lake.—(*L. McCarthy, United States.*)
22,961. ADVERTISING DEVICE, E. Bernheim and J. M. Audibert, London.
22,962. FORGED TUBULAR CONNECTIONS, F. W. Barthels, London.
22,963. GRINDING MACHINES. H. H. Lake.—(*The Piano Manufacturing Company, United States.*)
22,964. ELECTRIC CAR, P. Hébert and E. Cannevel, London.
22,965. SQUEEZING METALS, W. H. Beck.—(*C. Bétry, France.*)
22,966. AIR COMPRESSOR, F. A. McRae and C. E. Robertson, London.
22,267. ARC LAMPS, W. R. Ridings and Veritys, Ltd., Birmingham.
22,268. FORTUNE-TELLING APPARATUS, A. Haehle, London.
22,269. FOLDING POCKET LANTERN, J. Röhol, London.
22,270. WORKMEN'S TIME RECORDER, O. P. Theuerkorn, London.
22,271. BRONZE PRINTING MATERIALS, L. Burger, London.
22,272. HEATING LIQUID, W. Chattaway, Twickenham, Middlesex.
22,273. DRIVING GEAR for VEHICLES, M. Solomon, London.
22,274. TIPS for BILLIARD CUES, &c., H. Roberts, London.
22,275. FIXING PULLEYS, E. Birks and A. Posern, London.
22,976. COUPLING RAILWAY WAGONS, T. V. Collins, London.
22,977. DYEING YARN, H. H. Lake.—(*J. W. Fries, United States*)
22,978. AIR-PUMPING MACHINERY, W. A. Gorman, London.
22,979. AIR-PUMPING MACHINERY, W. A. Gorman, London.
22,980. WORKING in IRRESPIRABLE GAS, W. A. Gorman, London.
22,981. WORKING in IRRESPIRABLE GAS, W. A. Gorman, London.
22,982. PETROLEUM ENGINE, F. I. Grosse and P. Boubalt, London.
22,983. PIE-CRUST SUPPORTERS, G. R. Adcock and G. Castleden, London.
22,984. TOBACCO PIPES, E. S. Doré, London.
22,985. BAND BRAKES for CYCLES, J. H. Punchard, London.

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22,986. GAS REGULATOR and INDICATOR, W. H. Stevenson, London.
22,987. LETTER FILE, R. H. Taunton and G. Holloway, Birmingham.
22,988. TRANSPARENT ENVELOPE, H. G. B. Hunt, London.
22,989. ELECTRIC TRAMWAYS or RAILWAYS, F. Hewer, London.
22,990. PIVOT for SCISSORS, M. Schaack, South Norwood.
22,991. LIQUOR SALES INDICATOR, W. Kircaldy, Dundee.
22,992 BRAKE for BICYCLES, The New Grafton Cycle Company, Northampton.
22,993. CONSTRUCTION of TRAMWAY RAILS, L. Cooper, Bradford.
22,994. CENTRIFUGAL MACHINES, J. Laidlaw and J. W. Macfarlane, Glasgow.
22,995. DEFECATING CANE JUICE, R. A. Robertson, Glasgow.
22,996. STUFFING-BOX COCKS, J. Lumsden. Aberdeen.
22,997. WRENCHES, W. H. Robinson, Kingston-on-Thames.
22,998. THILL COUPLINGS, H. A. Luttgens, Kingston-on-Thames.
22,999. TOASTERS, G. F. Dewdney, Cardiff.
23,000. EGG POACHER, G. F. Dewdney, Cardiff.
23,001. BONDING ELECTRICAL RAILWAY RAILS, T. Kennedy, Manchester.
23,002. TIRE for ROAD VELOCIPEDES, A. Donnelly, Glasgow.
23,003. CONDENSER, D. A. and J. B. Blair and R. Baillie, Glasgow.
23,004. CYCLE BRAKES, W. Hanlon, Innishannon, Co. Cork.
23,005. SADDLES for VELOCIPEDES, A E. Kempston London.
23,006. FOOD CONTAINER, F. Böhme. Liverpool.
23,007. COMPASS, L. Myers and F. R. Baker, Birmingham.
23,008. RAILWAY WAGON COUPLING, J. T. Dugdale Warrington.
23,009. ELECTRIC WARNING SIGNALS, J. H. Hollyer Droitwitch.
23,010. SEATS, T. Finney, Glasgow.
23,011. LOOM PICKERS, W. Ashworth, Manchester.
23,012. WIND MOTOR or MILL, R. Perzina, Glasgow.
23,013. STAMPEDE STOPPER, C. Armstrong, London.
23,014. PROCESS for TREATING ORES, A. Germot, London.
23,015. BRAKES for WHEELS of CYCLES, T. Vann, Birmingham.
23 016. APPARATUS for INFUSING TEA, E. Rowan, London.
23,017. CYCLES, A. Gibbs, London.
23,018. SHOE, R. Owen and C. d'Esterre, Boscombe, Hants.
23,019. COUPLINGS for RAILWAY VEHICLES, W. Heslop, London.
23,020. ENGINES, W. H. Bushell and L. R. S. Tomalin, London.
23,021. ELECTRIC MOTOR VEHICLES, H. Sefton-Jones. —(*Kölner Accumulatoren-Werke Gottfried Hagen, Germany.*)
23,022. CUTTING KEYS, H. Sefton-Jones.—(*A. Garnier, France*)
23,023. VALVES, A. H. Harrison and H. Huddleston, London.
23,024. PROCESS of PURIFYING BRINE, G. N. Vis, London.
23 025. DYEING COTTON, H. E. Aykroyd and J. Graham, Liverpool.
23,026. TAPS, W. S. Worthington, Liverpool.
23,027. APPARATUS for MOUNTING TIRES, J. C. Anderson, Liverpool.
23,028. PACKING CASE, E. A. Olivieri and L. J. Kemper, Birmingham.
23,029. ELECTRIC TRACTION for TRAMS, H. Lane, Birmingham.
23,030. SADDLES for CYCLES, W. H. Butterworth, Birmingham.
23,031. CIRCULATING WATER, W. J. Foster, Birmingham.
23,032. BURNERS for INCANDESCENT LIGHTING, J. Y. Johnson.—(*Compagnie Française del' Acetylene dissous, France.*)
23,033 SECONDARY BATTERIES, W. Schlothauer, London.
23 034 GEAR for LIFTING MACHINERY, F. Dastmead, London.
23 035. COMBINED STUD and TIE HOLDER, J. A. Crane, Birmingham.
23 036. TUBULAR CONNECTIONS for CYCLES, C. G. Harrison, Birmingham.
23,037. OPERATING SHUTTLES of LOOMS, J. M. Cryer and W. E. Bullen, London.
23,038. WIRE-COVERING MACHINES, A. Kreidler, London.
23 039. PHOTOGRAPHIC APPARATUS, A Légé and W. H. England, London.
23,040. ELECTROLYSIS of ALKALI CHLORIDE SOLUTIONS, A. J. Boult.—(*F. Störmer, Germany.*)
23,041. OIL ENGINES, T. W. Naylor, London.
23,042. EXPLOSION MOTORS, W. Maybach, London.
23,043. VALVES for STEAM ENGINES, C. R. Boswell, London.
23,044. CHIMING APPARATUS, L. J. Smith and R. J. Rudd, London.
23,045. FOLDING LADDERS, V. Forir, London.
23,046. FEET of BEDSTEADS, S. I. Whitfield, Birmingham.
23,047. RADIOCONDUCTOR TUBES, E. Ducretet, London.
23,048. DRIVING GEAR for VELOCIPEDES, C. Ransom, London.
23,049. SECURING PNEUMATIC TIRES to RIMS, W. G. Berry, London.
23,050. DEVICE for DRAWING FORESHORTENED CIRCLES, A. Fye. London.
23 051. A TOY, S. E Rolls, London.
23,052. ADVERTISING, A. E. Grignon, L. C. F. Dhuicque, and M. P. B. David-Vaudey, London.
23,053. BALANCED ENGINES, G. V. L. Chauveau, London.
23,054. COUPLING APPLIANCES, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany.*)
23,055. CURRENT-COLLECTING APPARATUS, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany.*)
23,056. AIR COMPRESSORS, F. W. Scott and W. Harrison, London.
23,057. FERMENTING PROCESS for USE in BREWING, A Meyer, London.
23,058. SINGLE PILE VELVETS, R. Haddan.—(*The Firm of Gebrüder Wertheimer, Germany.*)
23,059. PHOTOGRAPHIC PRINTING SURFACES, O. Fulton and M. Gillard, London.
23,060. APPARATUS for OPENING SILK FIBRES, L. B. Magdid, London.

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23,061. HANDLES for TRACTORS, J. F. Le Page, Manchester.
23,062. APPARATUS for TREATING SKINS, A. Exley, Leeds.
23,063. CYCLE BRAKES, J. B. Brooks and J. Holt, Birmingham.
23,064. GULLIES, J. Place and Co., Ltd., and W. H. Place, Halifax.
23,065. MACHINES for DRESSING FIBRES, A. Mel o-, Huddersfield.
23 066. VALVE, A. W. Baxter, St. Leonards-on-Sea, Sussex.
23,067. PNEUMATIC TIRES, R. A. Hall, Newcastle-on-Tyne.
23,068. HEATING APPARATUS, J. Richardson, Hale, near Altrincham, Cheshire.
23,069. GAME, W. H Williamson, Bristol.
23,070. EXPANDING TIRE COVERS, J. Riley and T. A. Stewart, Manchester.
23,071. RECEPTACLE or HOLDER for MATCHES, O. Stark, Glasgow.
23,072. DISPLAYING ARTICLES in SHOPS, J. McD. Duthrie, Glasgow.
23,073. PURIFYING GAS, J. W. Bailey and J. Clapham, Keighley.
23,074. MUDGUARDS, G. Rankeillor and A. Dugdale, Manchester.
23,075. ROUTE INDICATORS for TRAM CARS, C. R. Bellamy, Liverpool.
23,076. FIRE-BARS for DOMESTIC FURNACES, J. Hough, Manchester.
23,077. ELECTRICAL SEWING MACHINERY, H. Chapman, Sheffield.
23,078. SLIDES for HEAD RESTS, J. Woodcock and M Platt, Nottingham.
23,079. JUG COVERS, H. C. Barker, junior, London.
23,080. SEWING MACHINES, J. A. Cameron, London.
23,081. PNEUMATIC TIRES, C. Hubbard, London.
23,082. LIGHTING LAMPS, G. F. L. Foulger and J. G. Glover, London.
23,083. UMBRELLA HOLDERS, W. Sanders, London.
23,084. KEYBOARDS of PIANOS, &c., F. L. Kingsford, London.
23,085. MANUFACTURE of COKE and CHARCOAL, A. Schenk, London.
23,086. STUDS, J. Cartwright and G. B. Underhill, Birmingham.
23,087. APPARATUS for CAGE HOISTS, A. Wadsworth, London.
23,088. GAS BURNERS and REGULATORS, J. Wilson, London.
23,089. CYCLE SADDLES, J. W. Richardson, Totteridge Green, Herts.
23,090. APPARATUS for OPENING JUTE ROOTS, C. R. Orr, London.
23,091. VALVES, A. F. Cole, Kidderminster.

23,092. VALVES for CYCLE TIRES, J. O. Dale and A. F. Cole, Handsworth, near Birmingham.
23,093. PINCE-NEZ and EYE-GLASSES, J. Aitchison, London.
23,094. APPARATUS for SIFTING PURPOSES, A. Oberegger, London.
23,095. STEREOTYPE CASTING APPARATUS, I. Lam, London.
23,096. RECORDING APPARATUS for TELEGRAPH LINES, J. A. L. Dearlove, London.
23,097. PRESSURE-CONTROL APPARATUS, J. F. Child and R. J. White, London.
23,098. STRETCHING FRAMES for YARNS, W. Herschmann, London.
23,099. LIGHTING INCANDESCENT GAS LAMPS, W. Edgar, London.
23,100. SUPPORTS for ELECTRIC LAMP, H. Long, London.
23,101. FEED-WATER HEATERS and PURIFIERS, L. Wehner, London.
23,102. CONTACT BREAKERS, G. Weissmann and A. Wydts, London.
23,103. HAT PINS, M. R. M. Anderson, London.
23,104. SO-CALLED FLY-CATCHING BALLS, S. Frenkel, London.
23,105. RUBBER TIRES, G. C. Marks.—(*The Rubber Tire Wheel Company, United States.*)
23,106. INCREASING ILLUMINATING POWER of LAMPS, J. G. L. Bormann, London.
23,107. PROTECTORS for TIRES, W. P. Thompson.—(*J. P. Legrand, France.*)
23,108. CASE for POCKET KNIVES, W. P. Thompson.—(*The Bayerische Celluloidwaarenfabrik vorm. A. Wacker, A. G., Germany.*)
23,109. STEERING TRACTION ENGINES, H. A. Flatman, London.
23,110. FLEXIBLE METALLIC COUPLING, W. Schmid, Liverpool.
23,111. PESSARY, E. Edwards.—(*G. Herrmann, Germany.*)
23,112. TILES, A. W. Squires, London.
23,113. WATER-HEATERS, T. P. Shaw, London.
23,114. ROUNDABOUTS, J. Sander and A. Koopman, London.
23,115. STARCHING MACHINES, W. H. Rickey, London.
23,116. IGNITING DEVICES for MOTORS, A. Dasse, London.
23,117. WARDROBES, A. Anderson and G. Adie, London.
23,118. PATTERN CHAINS of LOOMS, H. Eicken, London.
23,119. ILLUMINATING DEVICES, P. Jean and A. Bouchon, London.
23,120. "MERRY-GO-ROUNDS," F. Dillinger and O. Bockhardt, London.
23,121. CLINICAL THERMOMETERS, R. Cohen, London.
23,122. MANUFACTURE of INDIGO, &c., J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
23,123. PRODUCTION of INDIGO-LEUCO COMPOUNDS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
23,124. PUNCTURE-PREVENTING DEVICES, S. A. Bhise, London.
23,125. BRAKES for CYCLE WHEELS, F. G. Cundy, London.
23,126. GENERATING STEAM, T. W. Nordenfelt and A. Christophe, London.
23,127. COCKS for BEER BARRELS, W. C. W. Bruce, London.
23,128. GARMENTS for SAVING LIFE, S. A. Cazals, London.
23,129. PRODUCTION of COMPRESSED AIR, A. Martikke, London.
23,130. CRANK-DRIVING MECHANISM, H. Loewe, London.
23,131. PUMP for DOMESTIC PURPOSES, C. Baum, London.
23,132. EXPLOSION ENGINES, &c., N. A. Guillaume, London.
23,133. PORTABLE PNEUMATIC TOOLS, H. J. Kimman, London.
23,134. SUGAR-REFINING DEVICE, J. Robin-Langlois, London.
23,135. SIGNALLING, H. Skapski and W. Hochberg, London.
23,136. CYCLE BRAKE, H. Skapski and W. Hochberg, London.
23,137. GAME, W. Donisthorpe and F. S. Pillcau, Reigate.

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23,138. CONTROLLING the FLOW of LIQUIDS, W. P. Miles, Grove Park, Kent.
23,139. PORTABLE COPYING PRESS, J. Gill, Bristol.
23,140. TIME INDICATOR, J. M. Wilson and S. Faller, Glasgow.
23,141. ELECTRIC HOISTS, J. Goddard, Ashton-under-Lyne.
23,142. UTILISING POWER, T. and T. W. Whimster, Glasgow.
23,143. VALVES for PNEUMATIC TIRES, T. Dixon, Bradford.
23,144. STEAM WHIPPING ENGINE, T. Melrose, Tynemouth.
23,145. GAS or OIL ENGINES, J. Matthews and T. Vann, Birmingham.
23,146. GLASS CYLINDERS for LIGHTING PURPOSES, R. O. Tweedie, Galashiels.
23,147. JAPANESE GO-MERRALY, G. Tadda, Sheffield.
23,148. FESTOONING FLOORCLOTH, Rylands and Sons, Limited, and J. R. Hill, Manchester.
23,149. GENERATION of ACETYLENE GAS, J. W. B. Wright and E. A. Jeffreys, London.
23,150. WREATH STANDS, J. A. Brayshaw, Manchester.
23,151. TEACHING the USE of MARINER'S COMPASS, E. F. J. Spafford, Liversedge.
23,152. DIRECT-ACTING STEAM ENGINES, R. Richardson, Glasgow.
23,153. SWITCHES for RHEOSTATS, H. Hirst and F. O. Hunt, London.
23,154. ELECTRICAL INDICATOR, A. Eckstein and H. J. Coates, Salford.
23,155. BLOCK, W. E. Hutchinson, Selby.
23,156. ATTACHING LABELS to SACKS, J. Whelan, Dublin.
23,157. FIRE-EXTINGUISHING APPARATUS, J. Butcher, Wolverhampton.
23,158. EVAPORATING LIQUIDS, J. and C. McNeil, Glasgow.
23,159. KNITTING MACHINES, W. E. Heys.—(*L. Lépicier, France.*)
23,160. FLEXIBLE METALLIC HOLLOW TIRE, S. Campion, Brigg.
23,161. PORTABLE BED, T. Hampton, Bristol.
23,162. FLUE-CLEANERS for BOILERS, G. R. Davies, Leamington-Spa.
23,163. DRIVING MECHANISM for BICYCLES, J. M. Sellers, Keighly.
23,164. PNEUMATIC BOOT TREE, A. C. Pearce, London.
23,165. PLATE for DOMESTIC USE, J. Clarke, London.
23,166. SHOCKLESS IRON TIRE, R. J. H. Fox, London.
23,167. METALLIC CARTRIDGES, J. Y. Johnson.—(*R. W. Scott, United States.*)
23,168. FIRING MULTI-SHOT GUNS, J. Y. Johnson.—(*R. W. Scott, United States.*)
23,169. INJECTING and WATER-PULVERISING APPARATUS, A. Matossi, London.
23,170. CLUTCHES, H. M. Dinsdale, London.
23,171. PURIFYING FEED-WATER, A. J. Boult.—(*C. F. Bainter, G. W. Powell, and C. M. Persons, United States.*)
23,172. BAGS for TRANSPORTING COAL, J. S. Scully, London.
23,173. STOP-MOTIONS for LOOMS, J. Coldwell and C. G. Gildard, London.
23,174. PAPERHANGING PRINTING MACHINES, T. T. Butler, London.
23,175. FIBRE for MANUFACTURE of PORTMANTEAUX, T. E. Rowe, London.
23,176. AXLES of WHEELS, W. Shone, London.
23,177. CLOSING the ENDS of BOILER TUBES, E. H. J. C. Gillett, London.
23,178. BRANDING IRONS, F. Hughes, London.
23,179. GENERATING ACETYLENE GAS, T. G. Turner, London.
23,180. CLEANING COMPOUND, R. Haddan.—(*A. M. Waitt, United States.*)
23,181. SURFACE ORNAMENTATIONS, A. E. Meyer, London.
23,182. PRESERVING PRINTING SURFACE, H. J. Haddan.—(*The American Lithographic Company, United States.*)
23,183. MAKING PRINTING SURFACES, H. J. Haddan.—(*The American Lithographic Company, United States.*)
23,184. LITHOGRAPHIC MULTICOLOUR PRINTING, H. J. Haddan.—(*The American Lithographic Company, United States.*)
23,185. PHOTOGRAPHIC PRINTING APPARATUS, R. Haddan.—(*J. L. Browse, G. Mackay, and F. Quilty, United States.*)
23,186. PNEUMATIC RIVETING DEVICE, H. J. Kimman, London.
23,187. BEARINGS for VELOCIPEDES, J. W. Parker, London.
23,188. SUCTION STOPPERS of BOTTLES, F. Mülhens, London.
23,189. MARINE PROPELLERS, J. A. Hopewell, Ottawa, Canada.
23,190. WHEELS, D. G. Martens, London.
23,191. APPARATUS for CLEANING CASKS, D. G. Martens, London.
23,192. APPARATUS for DRYING CASKS, D. G. Martens, London.
23,193. VEHICLE, C. Erade, London.
23,194. PLANE, A. S. H. Whitelock, London.
23,195. FORM of MOSQUITO CURTAIN, J. Adam, London.
23,196. BOTTLES, J. R. Latham and R. Milbank.
23,197. SHOEING of DRAUGHT ANIMALS, E. Turpaud, London.
23,198. STEAM GENERATORS, J. Maudslay, London.
23,199. FRICTION CLUTCHES, B. E. Dickinson, Birmingham.
23,200. MECHANICAL MUSICAL INSTRUMENTS, E. P. Riessner, London.
23,201. WEAVING LOOMS, H. H. Lake.—(*The Sanford Mills, United States.*)
23,202 WEAVING LOOMS, H. H. Lake.—(*The Sanford Mills, United States.*)
23,203. MANUFACTURE of COKE, H. H. Lake.—(*Universal Fuel Company, United States.*)
23,204. MOULDS for FORMING ORNAMENTATIONS, W. H. Henay, London.
23,205. FASTENING DEVICES, J. T. Robin, London.
23,206. LATHES, J. Hartness, London.
23,207. DRYING PHOTOGRAPHIC FILMS, E. J. E. Helie, London.
23,208. FUSES for EXPLOSIVE PROJECTILES, J. C. Thompson, London.
23,209. REFUSE DESTRUCTORS, A. J. Liversedge, London.
23,210. AUTOMATIC COUPLING, W. Clark.—(*C. P. White and M. Burke, India.*)
23,211. BASCULE LIFT BRIDGES, J. P. Cowing, London.
23,212. VEHICLE WHEELS, C. F. V. Hansen, London.
23,213. COVERING, &c., LEAKS in SHIPS, A. Colomès, London.
23,214. SPRING-MOUNTED SOLE for BOOTS, J. Sikorszky, London.
23,215. NIGHTGOWNS for INVALIDS, M. F. Miles, Birmingham.
23,216. SWITCH, H. O. Joedicke, London.
23,217. DISPLAYING CINEMATOGRAPHIC PICTURES, O. Messter, London.
23,218. SHOE BRUSH, A. J. Howard, London.
23,219. ELECTRIC SIGNAL ALARM, A. J. Boult.—(*F. Cumont, Belgium.*)
23,220. TEAR-OFF ALMANAC, T. Pusch, London.
23,221. SELF-ACTING LUBRICATOR, H. Loose and G. Schreyer, London.
23,222. PENCIL HOLDERS, R. Jordan, London.
23,223. PICTURE HOOKS, O. Hensel, London.
23,224. BELT FASTENERS, J. M. Cavins, London.
23,225. MACHINE for KNURLING METALS, C. E. Billings, London.
23,226. CARRYING MAPS, S. Guttmayer and A. Collin, London.
23,227. FUMIGANTS, I. S. McDougall, F. Howles, and W. H. Yates, London.
23,228. PHOTOGRAPHIC FILM ROLL HOLDERS, W. Beutler, London.
23,229. INCANDESCENT GAS LAMPS, H. Winkler, London.
23,230. BOTTLE-CAPPING MECHANISM, W. P. Thompson.—(*C. H. Burleigh and F. O. Woodland, United States.*)
23,231. WASHING MECHANISM, W. P. Thompson.—(*M. C. and Z. S. Randleman, United States.*)
23,232. ROTARY ENGINE, J. Aufreckt, London.
23,233. PROCESS for PURIFYING GRAPHITE, E. Teisler, Liverpool.
23,234. STEAM GENERATORS, E. J. Clubbe and A. W. Southey, London.
23,235. SECONDARY VOLTAIC BATTERIES, H. Leitner, London.
23,236. WORKING GAS ENGINES, C. D. Abel.—(*The Gasmotoren Fabrik Deutz, Germany.*)
23,237. COLLAR STUDS and TIE FASTENERS, E. McCarthy, London.
23,238. INJECTING FUEL into FURNACES, E. A. Vetillard and E. Scherding, jun., London.

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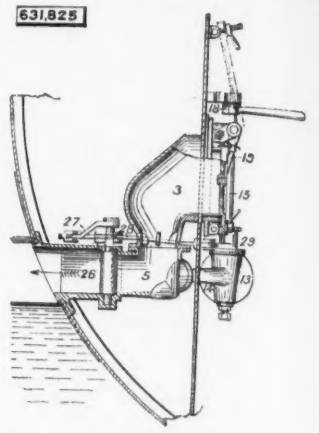
23,239. HARNESS BUCKLE, J. A. Gavitt, Kingston-on-Thames.
23,240. INCANDESCENT GAS MANTLE STEADIER, W. Palmer, Chorlton-cum-Hardy.
23,241. HOLDER for ELECTRIC LAMPS, R. Alexander.—(*A. B. Vance, Cape Colony.*)
23,242. MANUFACTURING ZINC PAINT, S. Cowper-Coles, London.
23,243. SOLE-LAYING MACHINES, G. A. Moore, H. J. Rosegrant, S. S. Williamson, and G. C. Hazelton, jun., London.
23,244. PIGEON FOUNTAIN or HOPPER, P. Clark, Great Malvern.
23,245. BAMBOO BEDSTEADS, H. Rickards, Birmingham.
23,246. CLUTCH WHEELS for CYCLES, C. Inwood, Gravesend.
23,247. CONSTRUCTION of CHAINS, W. Cooke, Liverpool.
23,248. APPARATUS for RAISING WATER, W. E. Hickling, Leicester.
23,249. COLOUR-GRINDING APPARATUS, T. Wyatt and C. Turner, Witton, near Birmingham.
23,250. FOOTREST for CYCLES, H. A. Reinhold, Woolwich.
23,251. CYCLES, A. W. Turner.—(*Eerste Nederlandsche Rijielfabriek, Holland.*)
23,252. DISTILLATION of ORGANIC SUBSTANCES, J. D. Campbell and W. H. Yates, Manchester.
23,253. PARTS for CYCLES, F. Westwood, Yardley, Worcestershire.
23,254. STAINING of HORN COMBS, D. B. D. Stewart, Glasgow.
23,255. ACETYLENE LAMPS, F. Armstrong, Manchester.
23,256. STATIONARY ENGINES, C. L. Turner, Manchester.
23,257. AIR-COMPRESSING ENGINES, J. Taylor and Taylor's Patent Air Compressor, Limited, Manchester.
23,258. WEFT PILE FABRICS, L. Fish, Manchester.
23,259. TREATING SOAP SUDS, S. and J. Turner, Halifax.
23,260. RAIL JOINTS, B. J. Maloney, Edinburgh.
23,261. CYCLES, H. S. H. Shaw and J. Bibby, junior, Liverpool.
23,262. COMBINED SEAT, J. Callie, Liverpool.
23,263. HOLDING BOOKSHELVES, J. Sharp, Bournemouth West.
23,264. HAND POWER BRAKES, D. J. Morgan, Barry.
23,265. INTERNAL COMBUSTION MOTORS, W. J. Crossley and J. Atkinson, Manchester.
23,266. INTERNAL COMBUSTION MOTORS, W. J. Crossley, Manchester.
23,267. TROLLEY, &c., G. J. Ball, Clontarf, County Dublin.
23,268. TOY, J. Cole, London.
23,269. SELF-ADJUSTING LADY'S VEIL, W. J. Flew, London.
23,270. BEDSTEAD-LOCKING APPLIANCE, H. Reinhold, London.
23,271. AUTOMATIC CONTINUOUS FIRE, A. O. von Augezd, London.
23,272. TILES, J. Middleton, London.
23,273. GLASS and TILE DECORATIONS, J. Middleton, London.
23,274. THROWING MOTORS OUT of GEAR, E. G. Dietze, London.
23,275. FIRE-ESCAPES, J. Y. Shallenberger, London.
23,276. BICYCLE RESTS, A. G. Shields, London.
23,277. FORCEPS, N. B. McGhee, London.
23,278. FAUCETS, E. Randolph, London.
23,279. AXE HANDLES, W. S. Marsh, London.
23,280. KNITTING MACHINES, W. Spiers and T. S. Grieve, London.
23,281. WHEELS for CYCLES and MOTOR CARS, T. Coad, London.
23,282. MICROPHONIC PANELS for ORGANS, F. A. Smart, London.
23,283. ELECTRICAL DISTRIBUTION, The British Thomson-Houston Company, Limited.—(*E. Thomson, United States.*)
23,284. ELECTRIC CIRCUIT BREAKERS, The British Thomson-Houston Company, Limited.—(*E. Thomson, United States.*)
23,285. ELECTRIC ARC LAMPS, The British Thomson-Houston Company, Limited.—(*E. W. Rice, jun., United States.*)
23,286. SCREW BONNET PIN, N. A. G. Ravenscroft, London.
23,287. HIGH VACUA, The British Thomson-Houston Company, Limited.—(*J. W. Howell, United States.*)
23,288. ELECTRIC ARC LAMPS, The British Thomson-Houston Company, Limited.—(*O. N. Wirwell, United States.*)
23,289. CONTROLLING ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*W. B. Potter, United States.*)
23,290. REGULATING ROTARY ELECTRIC CONVERTERS, The British Thompson-Houston Company, Limited.—(*E. J. Berg, United States.*)
23,291. ELECTRICAL DISTRIBUTION, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
23,292. ELECTRIC LOCOMOTIVES, The British Thomson-Houston Company, Limited.—(*The Union Elektricitäts-Gesellschaft, Germany.*)
23,293. TROLLEY STANDS for ELECTRIC RAILWAYS, The British Thomson-Houston Company, Limited, London.
23,294. ELECTRICAL GAS FITTINGS, H. J. Banks, Birmingham.
23,295. SECURING MITRE-JOINING FRAMES, J. A. Wilby, London.
23,296. A PROPELLING TOY, H. G. Robinson, London.
23,297. APPARATUS for the DEAF and DUMB, J. Parkes London.
23,298. PROPELLING MOTOR CARS, E. H. J. C. Gillet, London.
23,299. SLABS, V. Karavodine, London.
23,300. TELESCOPES for GUN SIGHTING, A. A. Common, London.
23,301. SECURING CORDS and CHAINS, A. E. Crawford, London.
23,302. EMPTYING BARRELS FILLED with PLASTIC MATERIALS, F. Smulders, London.
23,303. CELLULOSE COMPOUNDS, C. F. Cross, London.
23,304. EXTENSIBLE BEDSTEADS, M. T. G. Wrigley, London.
23,305. EXTENSIBLE FOLDING BED-COTS, M. T. G. Wrigley, London.
23,306. SELF-HEALING PNEUMATIC TIRES, E. Arthur, London.
23,307. BITS for HORSES, E. K. Crocker, London.
23,308. WHEELS for ROAD VEHICLES, E. C. F. Otto, London.
23,309. ACETYLENE GAS GENERATORS, G. G. Smith, London.
23,310. COUPLING for RAILWAY VEHICLES, G. Langford, London.
23,311. PROTECTIVE COVERING for SILK HATS, J. H. Mann, London.
23,312. STENTERING MACHINES for FINISHING TEXTILE FABRICS, A. A. Whitley, London.
23,313. FLYING MACHINE BALANCE, J. J. W. Hamilton, Penzance.
23,314. SQUARE FLYING MACHINE, J. J. W. Hamilton, Penzance.
23,315. ELECTROLYTIC METERS, A. Wright and The Mutual Electric Trust, Limited, London.
23,316. ELECTROLYTIC METERS, A. Wright and The Mutual Electric Trust, Limited, London.
23,317. YEAST, M. P. Hatschek, London.
23,318. MEDICAL APPLICATIONS of ELECTRICITY, R. Houghton, London.
23,319. ELECTRICAL MEASURING INSTRUMENTS, L. B. Atkinson, London.
23,320. ARTIFICIAL EAR DRUMS, &c., F. Wallfisch, London.
23,321. APPLIANCES for EFFECTING the LIGHTING of INCANDESCENT BURNERS, G. F. L. Foulger and J. G. Glover, London.
23,322. TREATING ORES, J. Swinburne and E. A. Ashcroft, London.
23,323. TREATING ORES, J. Swinburne and E. A. Ashcroft, London.
23,324. CYLINDER PRINTING PRESSES, F. J. Harbridge, London.
23,325. METAL CASES, L. T. and W. G. Furnald, London.
23,326. MEDICAL PADS, E. Edwards.—(*G. Herrmann, Germany.*)
23,327. DYNAMOS, R. A. Hadfield and W. F. Barrett, London.
23,328. GRIPPERS for CABLE CARS, S. A. Fraser, London.
23,329. FLOOR and CEILING, A. Speer, London.
23,330. CLUTCH MECHANISM, W. Fehlenberg and R. Schultz, London.
23,331. WATERPROOF FOOT COVERINGS, W. Speiss, London.
23,332. BOILER FURNACES and FLUES, G. A. Newton, Liverpool.
23,333. BOTTLE-MAKING MACHINERY, C. J. Bishop, Liverpool.
23,334. FISH-PLATES, I. Wohlfeld and L. Freundlich, Liverpool.
23,335. SKEWERS for WINDING SHUTTLES, M. Wa'sh, Manchester.
23,336. STEAM GENERATORS, T. Whitaker, Manchester.
23,337. METAL HANDLES, W. H. Wynn and H. W. Southall, Birmingham.
23,338. LIFE-SAVING APPARATUS, D. G. Martens, London.
23,339. TIME and DATE STAMPS, J. W. Stover, London.
23,340. MAKING POTASH, R. Haddan.—(*P. J. J. Roubertie, France.*)
23,341. VAPORISERS for ENGINES, F. W. Lanchester, London.
23,342. PACKING of PISTON-RODS, F. W. Lanchester, London.
23,343. BEARINGS of VELOCIPEDES, H. W. B. Bruno, Portsmouth.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

631,825. ASH EJECTOR, *H. See, New York, N. Y.—Filed May 4th*, 1899.

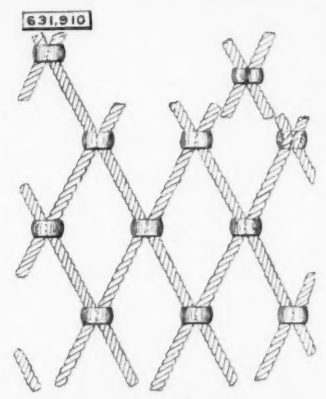
Claim.—(1) In an ash ejector wherein the ashes are ejected by means of a water jet, an ash receptacle having a door and an opening in said door through which air is drawn by the action of said jet, substantially as described. (2) In an ash ejector, the combination of the hopper 8, discharge pipe 5, jet pipe 14, communicating with a source of water under pressure, valve 26 in said discharge pipe, valve 13 regulating



the flow of water to said jet, rod 15, connections 27, 28, 29, between said rod 15 and said valve 26, projection 18 on said rod, and swinging door 19, substantially as described.

631,910. ROPE NETTING, *W. H. Swift, Boston, Mass.—Filed December 8th*, 1898.

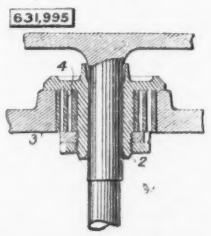
Claim.—(1) A rope netting comprising a series of cords or strands, and a series of clips or binders connecting said cords at intervals, each clip having a thickened middle portion, and flexible end portions which form, together with said middle portion, two inclosures in which the cords are embraced and com-



pressed, the said clips having rounded external and internal surfaces as set forth. (2) A clip or binder for rope nettings, having a central thickening or protuberance and flexible ends adapted to be bent or compressed around two contiguous cords or strands of the netting, said ends forming, in conjunction with said protuberance, two hooks or inclosures nearly surrounding the cords, the external and internal surface of the clip or binder being rounded.

631,995. JOURNAL BEARING FOR CENTRIFUGAL APPARATUS, *O. Ohlsson, Sidertelje, Sweden.—Filed February 11th*, 1899.

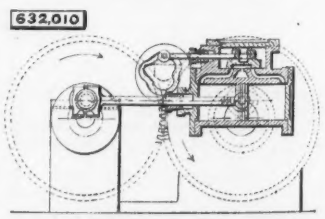
Claim.—(1) A journal bearing for an upright shaft having an unattached coiled spring occupying an annular space between the bushing of the bearing and the exterior box, said spring frictionally embrac-



ing said bushing and being coiled, counting from its inner end, in the same direction that the shaft rotates, as specified. (2) In a journal bearing for the shaft of a centrifugal apparatus, the combination with the outer box 3, and the bushing 2, of a coiled spring 4, of flat material occupying an annular space between said bushing and box, said spring being unconnected with the bushing and box except by friction, and being coiled, counting from its inner end, in the direction in which the shaft is to rotate, substantially as set forth.

682,010. STEAM ENGINE, *H. E. Gamble, Hoboken Belgium.—Filed June 23rd*, 1899.

Claim.—(1) In steam and other fluid-pressure engines, the combination of a pressure cylinder, a movable support therefor, and a crank, the parts being so connected that pressure in the cylinder will at the same time cause the cylinder to rotate in one direction and the crank to rotate in the opposite



direction, substantially as described. (2) In steam and other fluid-pressure engines the combination of a pressure cylinder mounted excentrically with reference to the disc or shaft which carries it, a piston or connecting-rod similarly mounted on a second disc or shaft, and means for connecting and controlling the motion of the two discs or shafts, substantially as described.

THE EFFECTS OF THE MANCHESTER SHIP CANAL.

IN February, 1897, Mr. A. Woodroofe Fletcher read a paper before the Manchester Statistical Society on "The Economical Results of the Ship Canal on Manchester and the Surrounding District." He has now enlarged on the remarks made in that paper by a further contribution recently published, which brings the whole subject up to date. The results shown are sufficiently full of interest to warrant our placing some of them, at all events, before those of our readers who may not have seen Mr. Woodroofe's papers. To begin with, we are told that in 1882, when the canal was projected, the city had entered upon a period not merely of arrested development, but of actual depression. For the three years ending 1879, there had been—to take one township alone—a yearly increase in the assessments of over £6000, making, in fact, some £20,000 in the three years. In the three years following, this increase actually turned into a decrease of nearly £1000, the difference between the increase and the decrease being £7000 a year. The decrease in the value of property was in consequence of the depression of trade. This was not only true of one district, it had universal reference to Manchester and the surrounding districts. During the previous ten years—but mainly during the previous six or seven years—a number of industrial concerns, engineering establishments, and mills in the New Cross Ward and a portion of the Ancoats district had been closed, or had ceased working. The number of hands affected was 12,650. Never, for forty years at all events, had there been so many warehouses unoccupied. One witness before the Committee of the House of Lords, when the Canal Bill was before Parliament, stated that of his own personal knowledge he knew of warehouse property standing empty whith ought to have been yielding £14,000 a year. In 1881 the number of uninhabited houses in Manchester was greater than the entire number of inhabited houses in the borough of Stockport. In Manchester and Salford there were 13,307 houses unoccupied. The average number of persons per inhabited house is slightly under five, but taking it at five, there was room for no less than 66,535 in 1881 in Manchester and Salford. This is 6982 more than the entire population of Stockport. The net annual rateable value of the city showed a steady and unbroken increase year by year from 1871 up to and including 1881. In the ten years ending with 1881 there had been a total increase of £597,598, or an average of nearly £60,000 a year—some 3·07 per cent. per annum. Had this increase been maintained during the next ten years the annual value should have been £3,092,649. As a fact, the value was £2,286,499 in 1891. There was an actual decrease of £14,726 for the ten years, instead of an increase, had the rate previous to 1882 been maintained, of £806,150. As a fact, however, the depreciation was arrested in 1889, though, for comparison's sake, the figures have been taken on to 1891. In Salford, be it said in passing, the periods of increase and decrease correspond pretty generally with those of Manchester, but the figures do not seem to indicate that either the depression or the signs of returning prosperity are so marked as in the adjoining borough.

The improvement in the direction mentioned, as in many others which we shall mention hereafter, is laid down to the door of the Ship Canal, which was opened for traffic on the 1st January, 1894. Previous to this we are told that its influence had been felt in the district. A large proportion of the cost of construction expended in wages must have given considerable impetus to a number of trades; and not only this, but before the opening of the canal the railway companies had made such reductions in their rates of charges as materially to help industries which had been up till then suffering depression on this account. The actual results of the construction of the canal must be judged not only by the cost of commodities imported and exported by it, but also by the reduced cost of commodities in consequence of the lower railway charges directly resulting from the anticipated competition of the canal. Once the canal opened, however, the improvement of affairs which had commenced beforehand, as though in anticipation of what was to follow, began in earnest, and has continued up till the present time. The rateable value of the old city area, not including the townships added in 1881 and 1891, is higher than it has ever been before, though it has not been increasing so fast just lately. This, of course, is due to the fact that the whole area is practically built on, and an increase in rateable value can only occur where old buildings are pulled down and new houses of greater value are built. The figures for the whole city, plus the extensions made in 1891, give a better idea of the real way that the wave of prosperity has progressed. There has been a rise every year varying in extent from ·41 per cent. to 2·99 per cent.—this in 1898-99—and the total increase in the eight years has been from £2,798,005 to £3,109,690, *i.e.*, £311,685. Building operations, too, began to be carried on. Between January, 1895, and July, 1896, no less than 8800 new houses were built, and within the city area alone—which, it must be remembered, was even in 1891 practically all built over—there were 8034 new dwelling-houses certified for habitation between 31st October, 1896, and 30th May, 1898. The development of correspondence delivered by van and postman increased at the rate of 10 per cent. per week between January, 1895, and July, 1896. During this period the increase per week alone amounted to a number equal to the whole correspondence of a town like Derby. Since that time the increase has been nearly 16 per cent. per week.

Statistics of the revenues from the Manchester Corporation departments show a wonderful state of affairs. The supply of water from Thirlmere has not cost the citizens anything additional in the way of rates, nor even in the charge for water. In 1896 the area of supply was 137 square miles, and the estimated population was 1,000,000 persons. In 1893 the revenue was £245,195. In 1896 it was £280,826. In 1897 it fell slightly to £280,198 in consequence of a reduction in the charges for water. It has risen consistently during the two last years, however, and was this year £312,041, or 6·10 per cent. greater than in the previous year. Even in 1896 it was evident that, owing chiefly to the expansion of the city and district, the revenue from the assessment of property and the sales of water would be sufficient to pay the interest on the money borrowed for the purchase of the Thirlmere estate and the construction of the waterworks, and at the same time to provide the necessary money for the sinking fund. Not only this, but actually the public water rate has been lately reduced 2d. in the pound, the charges for water for domestic purposes have been reduced 1d. in the pound, and 5 per cent. discount is now allowed off all accounts for supplies of water by meter amounting to 10s. per quarter and upwards. This is a highly satisfactory state of affairs, and it does not end here. The gas and electric undertakings are equally prosperous. In 1893 the revenue from the sale of gas was £555,565. In 1896 it was £515,569, but the price of gas had been in the meantime reduced 3d. per thousand feet, and the revenue from electric lighting had grown from £15,000 in 1894 to £38,118 in 1896. Since then the revenue from gas has become £594,970, and this in spite of the meter rents no longer being exacted, and the fall in the price of bye-products having been very marked; and the revenue from electric lighting for this year is no less than £71,941.

As to the Canal itself, there is considerable difficulty in gauging accurately the savings effected in the cost of carriage. "This is not," we are told, "because of there being any want of reality in the fact, but because the data available are only partial, and do not accurately or absolutely gauge either the weight of traffic affected or the total saving thereon." Some extremely interesting facts are, however, forthcoming. A rough estimation of the traffic which finds its way from the district lying within, say, ten miles of Manchester to the westward and fifteen miles to the eastward, and the Mersey ports, was in 1896 4,000,000 tons. Taking the rates of 1882 as a comparison with the rates in 1896, the author of the paper estimates the advantage to be, on the average, 1s. 6d. per ton. This would mean a saving of £300,000, or, allowing for the reduction in the price of cotton and cotton goods made in 1883—though it is an arguable point as to how far these reductions were caused or influenced by the Ship Canal—a saving of £200,000 per annum. To this sum is added a further £90,000 a year, which, it is estimated, represents the amount shipped from Manchester by other ports than Liverpool. These two together make £290,000 per annum, and this is what Mr. Woodroofe considers is the amount saved to Manchester by general reduction in rates. He further credits the canal with a saving of £200,000 a year on the goods it carries itself. Not only this, but oversea charges have become less. The rate per ton of 40ft. from Manchester to Bombay was, in 1892, 23s. 6d.; in 1896 it was 21s.; the rates to the East Mediterranean were reduced by one-third in the same time. Freights were also reduced from 10 to 20 per cent. as regards Hamburg, from 5 to 27 per cent as regards Antwerp, and from 5 to 40 per cent. as regards Rotterdam. Spanish trade has been more or less influenced, and in some instances there has been a reduction of as much as 50 per cent. Ten per cent. has come off the West African rates, and the charges ruling between Manchester and Glasgow were in 1896 25 per cent. less than those which obtained before the construction of the Ship Canal. The Mersey Docks and Harbour Board made reductions in their charges, the majority of which were over 20 per cent. In 1896 the North American trade was carried on from Manchester at the same rates as those charged from Liverpool. A list of eighteen towns round Manchester is given, and this shows the comparative cost of conveying various commodities either *viâ* Liverpool or through the canal. The average saving by the latter route on cotton is 5s. 3d.; on oil, 6s. 3d.; on tinned meats, 8s. 1d.; on timber, 4s. 4d.; on flour, 4s. 8d.; and on grain, 3s. 6d. In 1896 there was the greatest increase in the returns of the Manchester Clearing-house that there had ever been. It was £23,853,432, and represented an increase of 14·05 per cent. over the previous year. Then, too, taking the two railways which take most of Manchester's traffic—the London and North-Western Railway and the Lancashire and Yorkshire. The increase in the returns of these was, in 1896, £680,701, or an increase of 4·20 per cent. on the previous year. In fact, in each of the six years following the opening of the canal all the railway companies in the district show an increase, and the author says that "it does not seem unreasonable to assume that, at least, a portion of these increased receipts is due to the beneficial effect of the Ship Canal on the trade of Manchester and Salford and the surrounding district."

The prosperous conditions existing in 1896 seem to have been well maintained this year in every direction. The following table gives the amount of traffic on the canal itself in each year since it was opened:—

Year.	Sea-going traffic in tons.	Barge traffic in tons.	Total traffic in tons.	Increase.		Revenue—Increase.		
				Tons.	Per cent.	£.	£.	Per cent.
1894	686,158	239,501	925,659	—	—	97,001	—	—
1895	1,087,443	271,432	1,358,875	433,216	46·80	137,474	39,573	40·42
1896	1,509,658	316,579	1,826,237	467,362	34·39	182,330	44,856	32·62
1897	1,700,479	365,336	2,065,815	239,578	13·11	204,664	22,334	12·24
1898	2,218,005	377,580	2,595,585	529,770	25·64	236,225	31,561	15·42
1899 to June.	1,116,775	209,046	1,325,821	—	—	124,183	—	—

A large number of firms is building, or has built, stores or works along the banks of the canal. Many have opened offices at the docks as timber importers, while others are conducting their import business, *viâ* the canal, from their city offices, or through the Ship Canal Company, acting as their forwarding agents. A large grain elevator, with a capacity of 40,000 tons of grain, has been constructed at the Manchester docks. The Trafford Park estate has been purchased, and here many works and other buildings have already been erected or are in course of erection. The development of the trade of the Manchester district has evidently been very real and very extensive during the last few years. The advantage of using the canal and Manchester over Liverpool and the railways is still greatly felt in a large number of cases. There was a drop in the Clearing-house returns in 1897 amounting to ·28 per cent.; but in 1898 the amount passing through was £203,971,933, the largest amount on record by over £10,000,000. The returns for the present year indicate that this rate of increase is likely to be maintained.

The author is inclined to put down practically the whole of this revival in trade to the Ship Canal. He thinks that few will hesitate to say that, whatever minor forces may have contributed to the general result, the one cause which far outweighs all others, is the opening for traffic of the Ship Canal. The period of depression already referred to was attributed at the time to the keen competition to which Manchester was subjected by reason of the cost of transit of goods compared to that to which other manufacturing centres were put. This cause of depression has, it is urged, been largely removed by the canal. Surely, says the author, "the quickening of local commerce and the revivifying of local industries, which we now see are not merely the periodical flowing of the tide of prosperity, to be followed at no distant date by a corresponding ebbing of the tide, but . . . they are the signs of a permanent accession of wealth and material well-being." Moreover, he, for one, cannot but believe that the same spirit which has conquered the difficulties of the past—and they have been many—will overcome whatever difficulties may still remain, and that the near future will bring an ample realisation of those common hopes and aspirations by which the citizens of Manchester are knit together.

BRITISH AND AMERICAN MACHINE TOOLS.

No. III.

THEIR COMPARATIVE DURABILITY AND COST.

WHEN we come to compare the durability of the English with that of the American machine tools, the former undoubtedly have the advantage. In the first place, the mixture of cast iron used in the construction of American machine tools is, as a rule, considerably softer than that employed in our own; and consequently it is found that the faces of cast iron slides, which are in constant motion, wear more rapidly than those of machines made in this country. On the other hand, the Amerian metal, though soft, is particularly tough, and not very liable to fracture.

Another weak point in American machinery is, that one often finds small parts manufactured in cast iron where wrought iron or gun-metal could be more advantageously employed; and the occasional fracture of these pieces sometimes entails a temporary breakdown. Again, the smaller American machine tools, as mentioned in a previous article, are often considerably lighter than similar machines manufactured in England. One must not, however, lose sight of the fact that the smaller American machines are usually designed to deal expeditiously with special classes of work, thus for general turning and screwing of small wrought iron or steel spindles, the American will employ a light and comparatively inexpensive lathe; which is, however, amply strong enough for this purpose. The Englishman who, tempted by its low price, has purchased a machine of this description, and expects to employ it satisfactorily on general work, including the taking of heavy cuts on cast iron, will certainly be disappointed in the results; and, should a breakdown occur, is perhaps inclined to condemn the tool as being too weak and not durable. The fact is, that where a tool has a good chance of being kept continually employed on one class of small work, it is quite possible to use light and inexpensive machines to great advantage; but in this country, where the work in an average machine shop is a great deal more varied than in America, it becomes necessary to allow a considerable margin of strength for contingencies.

In the larger machine tools for heavy work, the American manufacturer does not, as a rule, err on the side of weakness or lightness of construction, and, with the exception of the cast iron surfaces before mentioned, this class of machinery, as regards durability, will, in many cases, bear comparison with our own.

After all, are we not inclined to attach too much importance to the durability of our machines? Formerly, when skilled labour was comparatively cheap, and manufacturers of machinery few, this point was without doubt a matter of great importance; and one could sympathise with the owner of a tool who, having done it up thoroughly after, say, twenty-five years of hard work, could point out with pride that it was as good as new. Now-a-days, when labour is costly, the firms who manufacture machine tools innumerable, and scarcely a day passes without improvements being introduced, the durability of a machine beyond a certain limit not only ceases to be an advantage, but is positively undesirable.

In many business concerns, the people controlling the finance are not directly interested in the actual details of manufacture, and hesitate when requested to provide funds for the purchase of new tools, preferring to repair the old ones when possible; but, under present circumstances, to repair a machine even a few years old, and make it as good as a new one, is usually a matter of impossibility, for the simple reason that, however well the repairs may be executed, a tool of this age will not for a moment keep pace with a modern machine in its powers of production. If therefore a machine, subject to the usual repairs to keep it in running order, will last and do its work with economy and rapidity for a reasonable number of years, it will be far more economical in the

long run to replace it when worn out with one of modern construction, rather than to do it up, even if the repairs can be carried out at a comparatively slight cost.

Without doubt, many manufacturers would be in a better position at the present moment had their original machinery been less durable, and had they been forced, in consequence, to keep their plant up to date from time to time by the purchase of new machinery.

We now come to the question of the comparative cost of machine tools manufactured in the two countries, and on this point, the practice before mentioned of systematising in manufacture gives the Americans quite as much advantage in economy of production as in the efficiency of their goods. In the first place, a firm which produces one or two classes of machine tools only is not hampered by heavy trade expenses to anything like the same extent as a concern which undertakes the manufacture of every variety. Its drawing-office and pattern-shop—two departments which, though a necessary standing expense, do not immediately contribute to the profit on capital invested—are reduced to a minimum. The expense of getting up catalogues and other printed matter is kept within reasonable bounds. Greater economy is possible in the purchasing of material, as a concern with a trade in one class of goods can, of course, order larger quantities of material needed for its special work at a correspondingly lower price than a firm whose variety is so large that it is impossible to foretell what class of goods it is likely to be called upon to manufacture from day to day, and which, in consequence, is obliged to carry a large but varied stock of raw material. But the saving which can be effected in the actual manufacture of large quantities of one article is, of course, by far the most important point, and, starting therefore at the commencement, we will deal first with the question of castings.

Broadly speaking, the employment of machines for moulding purposes in America is far more general than in

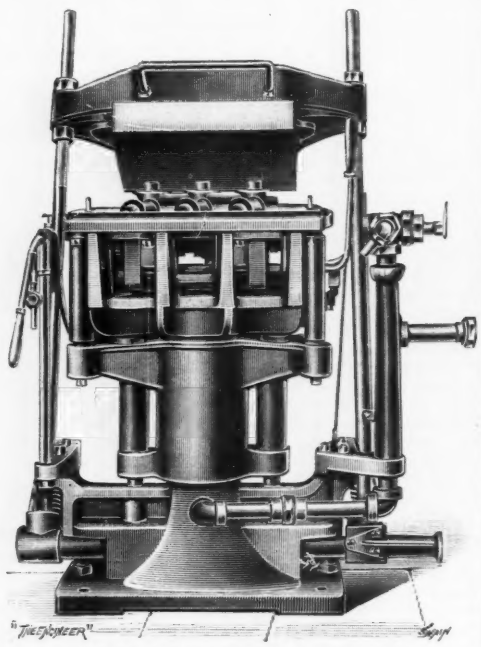


Fig. 1—TABOR MOULDING MACHINE

this country, and here, again, as at every point, the question of specialising comes in. In England the variety is, as a rule, so great that moulding machines can comparatively seldom be used with profit by the manufacturers of machine tools. In America, on the contrary, where large quantities of one article are often turned out, the saving effected by the use of machinery for this work is enormous. Furthermore, by its use, the standard of excellence, in small work especially, is greatly increased

There are two types of moulding machine now employed in America, either of which is greatly in advance of anything we can show in this country. The first, the "Tabor" machine, Fig. 1, is an expensive but highly ingenious and efficient tool. It is driven by means of compressed air, and is operated in the following manner. The patterns, which are mounted on a plate, are attached to the table. A moulding box is then placed on the top, which is filled with sand in the usual way. A ramming head, actuated by compressed air, is brought down, and the mould rammed by a single blow. The plate on which the patterns are mounted is lightly vibrated with a pneumatic rapper, working at a very high speed, while the patterns are at the same time withdrawn; the operator lowering the table by hand.

The second, the "Pridmore" machine, Fig. 2 and 3, is very simple and far less costly than the "Tabor." There is nothing new about the principle of its mechanism. Indeed, the late Mr. James Howard, of Bedford, as long ago as 1856, took out a patent for a machine of somewhat similar type; but though such machines for many years past have been, and still are, in use for producing light castings from simple patterns, when deep patterns with an irregular parting had to be dealt with, great difficulty has been experienced hitherto in making machines sufficiently accurate to ensure good moulds.

The general construction of the "Pridmore" moulding machine is as follows:—The main framing is formed in one casting. The table carrying the pattern is raised and lowered inside the framing by means of a crank motion. When the table is raised ready for ramming it is locked in position by the crank passing slightly beyond the centre. The amount of draw to suit patterns of different depths is regulated by a set screw and lock nut. All the operations on this machine, including the ramming and the withdrawing of the patterns through the plate, are performed by hand, but the system of working is entirely different to that hitherto adopted. The machine, instead of being fixed to the floor, is moved along a sand heap, the moulds, as they are made, being laid behind the machine in rows; thus, a large amount of time and labour in carrying sand and boxes to the machine is economised, and the workman is enabled to devote the time thus saved to the actual operation of moulding. When the moulds are completed, they are poured and shaken out, the sand sifted and thrown back on to the heap again, and the operation repeated. These machines are made in two hundred different sizes, the largest being 10ft. in diameter. The McCormack Harvesting Machine Company, of Chicago—a concern which turns out 280 tons of metal a day—uses no less than three hundred of these machines, and dispenses with the services of skilled moulders altogether.

The following table is compiled from data collected from a few of the smaller standard castings manufactured

Fig. 2—PRIDMORE MOULDING MACHINE

by this firm, and will give a good idea of the enormous economy effected by the use of machinery for moulding purposes when properly applied. The numbers given are authentic, having been taken from the books of the firm in question. No 1 is a bevel wheel with pinion cast on a long boss. No. 2 is a bevel wheel with webbed arms. No. 3 is a bevel wheel with a long boss. Nos. 4 and 5 are small bevel pinions. No. 6 is a special spur wheel, with six arms and projections on the boss. No. 7 is a six-armed spur wheel. No. 8 is a small spindle and clutch combined.

No	Weight of each piece in lb.	Quantity moulded in one box.	Diameter of box	No. of men employed.	No. of castings manufactured in 10 hrs.	Piecework price of each m'nufactured by hand.	Piecework price of each m'nufact'red on machine.
			in.			d.	d.
1	14	1	14	2	225	4	0·9
2	12	1	12	2	260	3¾	0·8
3	11	1	14	2	225	4	0·9
4	3	4	12	2	950	0¼	0·08
5	1·1	4	10	1	760	0·3	0·06
6	24	1	18	2	170	6	1·5
7	20	1	18	2	225	4	1·0
8	3·6	4	14	2	600	1½	0·37

The cost of core-making, which operation is performed by boys, is not, of course, included in the above figures; but the prices given allow for the placing of the cores in position and pouring the metal. To sum up, it is claimed that by the use of machinery the average cost of this labour, exclusive of trade expenses, on castings of this type has been reduced from £2 per ton when moulding by hand to 11s. per ton when using machinery. It is clear from the above that provided one has sufficient repetition work in the way of castings, the use of machinery is a great economy; but unfortunately the great variety of work undertaken by most of our machine-tool makers entirely debars many of them from its use, and when this is the case the American manufacturer who specialises has a considerable advantage over his English competitor in the production of his castings.

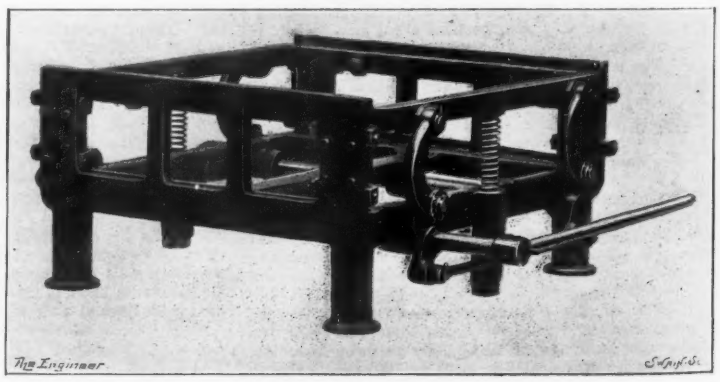


Fig. 3—PRIDMORE MOULDING MACHINE

India Rubber.—So long as the rubber industry of French Guinea continues to flourish, the prosperity of this Colony is assured, but the natives are obliged to go farther back into the interior to collect the rubber, and at the present time a great deal, we are told, comes from the French Soudan. Therefore, although French Guinea has succeeded in strangling the trade with the British Colony of Sierra Leone, she is bound to find a formidable rival in this neighbouring French possession.

HARBOURS AND WATERWAYS.

The Weaver.—By an Act obtained in 1893 the trustees of the river Weaver were given power to construct swing bridges across the navigation at Northwich, and recently the second of these bridges has been opened for traffic. These bridges are of special construction. Owing to the continual subsidence of the ground from the operation of the salt works, it was necessary to devise some plan by which the weight of the bridges could be carried without their resting on the ground. To meet this difficulty, Mr. J. A. Saner, M. Inst. C.E., the engineer to the Trust, has constructed steel pontoons, which float in the water and carry the bridges. These are so arranged as to permit of easy adjustment at the land ends. The bridges are thus independent of any effect of settlement of the ground, beyond the adjustment of the connection of the bridges with the land. Further, these bridges are noteworthy from the fact that they are opened and closed by electric motors, which are controlled by the man on duty in the houses at the bridges. A further improvement has been made in the navigation by the removal of the locks at Newbridge—which were a source of much obstruction—by which the water level between Newbridge and Vale Royal has been raised, so that vessels of 400 tons burthen now navigate the river. Altogether, £70,000 has been expended in improving the navigation, the two bridges costing £25,000.

Sunderland.—As the new pier works are now approaching completion, forming a harbour of refuge at the mouth of the Wear, into which vessels can enter at almost any state of the tide, the extension of the docks and other interior works of improvement are to be taken in hand. About 8½ acres are to be added to the Hudson Dock North, and coal shipping places erected, which will allow of the shipping of coal into the largest vessels likely to come into the port. New timber storage ground is also to be provided. The outlay on these works is estimated to cost £200,000.

Hastings.—There seems a fair prospect at last of the completion of the harbour at this place, which was commenced in 1896, and the works of which have been at a standstill for nearly two years. The original contract was taken for £120,000. It was found, however, that this sum was not sufficient, and as no more capital could be raised without security, the Corporation were asked to guarantee 3 per cent. on £100,000. After considerable difficulty, and in spite of a rather unfavourable report obtained by the Corporation from Sir Douglas Fox, as to the design and execution of the completed portion of the works, a resolution was carried agreeing to guarantee the interest on the amount which it is estimated will be required to complete the harbour, and the necessary parliamentary sanction was obtained in the last Session. This was, however, coupled with the condition that the works already constructed were to be put in a condition, and the remainder completed, to the satisfaction of an engineer appointed by the Corporation. Some difficulty was found in procuring the services of this engineer, but finally Mr. Stileman was appointed. His report contained several adverse criticisms on the work, and expressed the opinion that to put the harbour in a safe condition would require a sum of £66,000 beyond that intended to be spent. With this report Mr. Carey, the Commissioners' engineer, and the contractors joined issue, with the result that the engineers respectively of the Commissioners and the Corporation, and the contractors, became for a time hopelessly at variance, and since the Act was obtained there has been a deadlock. After repeated conferences, some understanding seems now to have been arrived at. The main matters in dispute having been adjusted, the remainder are to be referred back to the engineers, whose report will be received at a further meeting of the Corporation.

Newcastle.—This place, which is a favourite seaside resort in the north of Ireland, has also a considerable fishing population. For the service of this fishery principally, about forty or fifty years ago, a harbour was constructed by the Board of Works; and by an Act obtained in 1855, the duty of maintaining the harbour was imposed on the Grand Jury of the county of Down, the funds to be obtained from the county cess. This duty the Grand Jury declined to undertake, and have always refused to find money for the maintenance of the harbour, which is now in a serious condition. This refusal was based on the ground that, owing to bad designing and construction, the pier was not likely to stand. So a few years ago, some agitation being got up by the fishermen and others as to the condition of the piers, and a firm of contractors having offered to ship 1000 tons of granite weekly from their quarries if facilities were provided for the berthing and unloading of vessels, expert opinion was sought as to the cost of restoring the harbour, and a report was made to the effect that the site of the piers had been badly chosen, and even if repaired would never stand the action of the sea. After some negotiation the Government offered a grant of £5000 towards the £13,000 required for the rebuilding of the piers in a different position, which was looked upon as an acknowledgment of the original faulty construction; and the Grand Jury were asked to find the rest of the money, and when the work was completed to maintain the harbour. The Grand Jury have offered to contribute the £8000, and afterwards maintain the works, provided the Government will undertake the reconstruction, and thus for the present the matter rests.

UTILISATION OF HIGH-FURNACE GASES FOR POWER IN GAS ENGINES.

By ERYAN DONKIN, M. Inst. C.E.

No. II.

THE pioneers in the application of high-furnace gases to gas engines were, on the Continent, the eminent firm of the Société Cockerill, at Seraing, near Liège, in Belgium. In 1895, two engineers of the company, MM. Bailly and Kraft, were deputed to visit different countries, and report upon the question of the relative merits of gas and steam engines. Having come, after careful study, to the conclusion that the future development of the gas engine was the most promising, M Greiner, director of the works, desired them to select the best type of motor for testing with lighting and producer gas. It was during these trials that the idea occurred to M. Bailly of driving the engine with the gases given off from the high furnaces, of which there are six at Seraing, and thus to utilise, if possible, the enormous reserve of motive power practically going to waste. The construction of the gas engine thus preceded this novel application to it of the new power agent. The type selected was the Simplex of MM. Delamare-Debouteville and Malandin. A small 4-horse power engine was started, and although intended to work with lighting gas, from December, 1895, onward it gave satisfactory results when driven with high-furnace gases. It is to M. Bailly, aided by M. Kraft and M. Delamare, the designer of the Simplex, that the initiative at Seraing is due. They worked independently, and in ignorance of what was being done elsewhere in England and Germany.

The Simplex engine was selected because it was the largest gas engine made in France, where it enjoyed a well-earned reputation. It is a 4-cycle motor, but differs in a few ingenious respects from the Otto. It is made with one cylinder only for all sizes, and has one piston working on to the motor shaft through one crank. The charge is fired electrically by a special method. There is a small slide valve worked to and fro by the valve shaft, a part in which is brought to face the opening to a cavity where a series of electric sparks are continuously generated, and not, as in most engines, separately produced for each explosion. The little 4-horse power experimental motor was started on 20th December, 1895, and ran sixteen hours a day for eighteen months without intermission, driving several machine tools. Samples of the blast furnace gases at Seraing having been previously tested by Professor Witz, it was found that their composition and heating value varied less than had been anticipated, but several modifications were required before really satisfactory results were obtained. Here, however, the managers of the trials were guided by the experience already available in driving the Simplex engine with cheap or power gas, from which high-furnace gases do not greatly differ. After improvements effected in the working parts, the engine developed 8-horse power instead of 4 horse power; a description of it will be found in M. Hubert's article in the *Annales des Mines de Belgique*. The results of the tests, although good, were more or less approximate, and worked out rather higher than is now usual, because the consumption was not measured in a gauged gasholder, and the engine was seldom worked at full power. In an experimental engine the working conditions cannot be wholly satisfactory, when testing a new power agent. It is noteworthy, however, that no difficulty was from the first experienced with the dust.

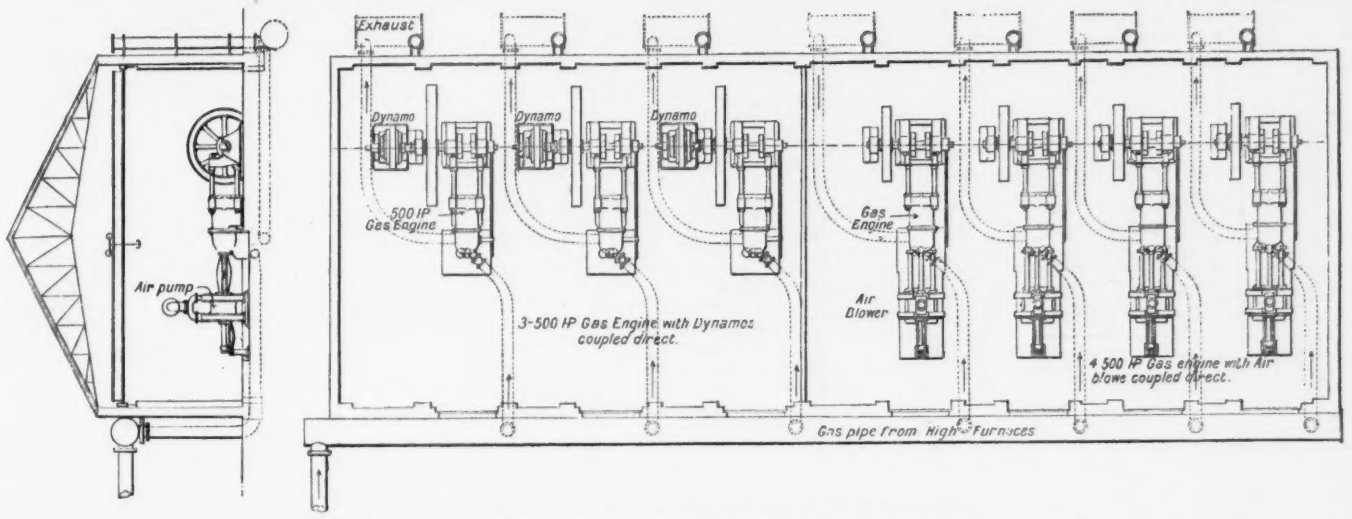


Fig. 3—DIFFERDINGEN IRONWORKS—GAS ENGINES, WITH DYNAMOS AND BLOWERS DIRECT-COUPLED

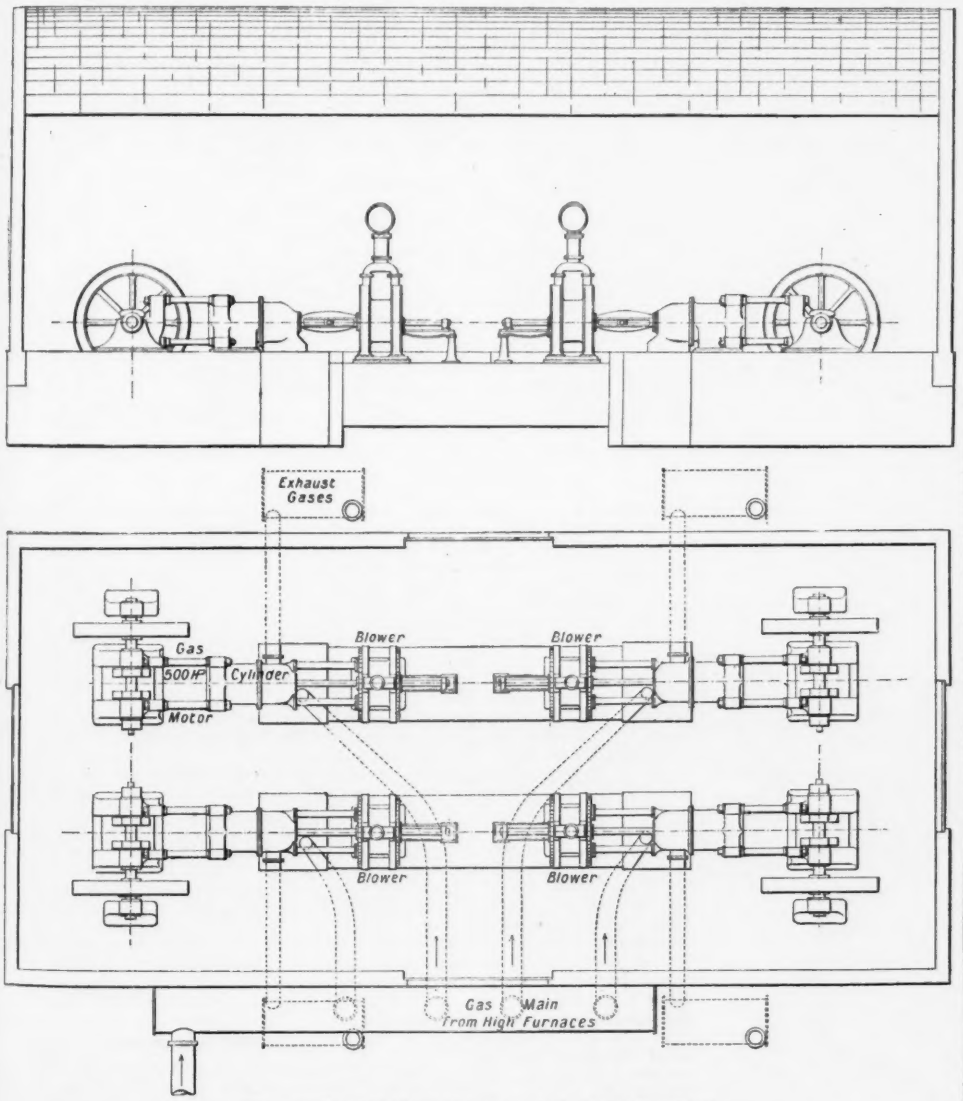


Fig. 3a—SIMPLEX GAS ENGINES AT THE SERAING WORKS

Encouraged by the success of these tests, the managers of the Seraing Works began in 1897 the construction of a 200 horse power single-cylinder Simplex engine, which started work in April, 1898. This engine, the fruit of two years' experience, was tested in July of the same year by Professor Witz. The diameter of the cylinder was 800 mm. = 31·5in. stroke 1000 mm. = 3·28ft., speed 105 revolutions per minute. The trial lasted for twenty-four hours, during which time the engine was supplied with gases from four furnaces worked as usual, no attempt being made to provide a specially rich gas free from dust. The gases were measured through a gauged holder, and samples were taken every half hour to determine their calorific value; they do not appear to have been analysed. The engine developed 181-horse power on the brake; mechanical efficiency 85 per cent. The mean consumption of high-furnace gases per brake horse-power hour was 3·33 cubic metres = 117·5 cubic feet. The calorific value of the gas was 981 calories per cubic metre = 109·8 B.T.U. per cubic foot. The engine ran with great regularity, and there were practically no variations in the speed and in the consumption of gas. At Seraing the gases are led from the furnaces successively through three pairs of coke scrubbers, or six scrubbers in all, each being 5ft. × 19½ft. The consumption of water for these scrubbers during the trial was 30 litres = 6·6 gallons per brake horse-power per hour. The gases are induced from the top of the furnaces by a Koerting steam-jet, which also helps to wash them. From the scrubbers they pass to a holder of 10,600 cubic feet, but the latter is not always necessary, being chiefly used for testing, or as a reserve. The fly-wheel of the engine is 13ft. in diameter, and weighs 15 tons. The charge of high-furnace gas and air is compressed in the motor cylinder to 8 atmospheres = 114 lb. per square inch. As regards the dust in the gases when they leave the furnace, they contain about 10 grammes per cubic metre. Half of this is metallic dust, which is returned to the furnace; about 3 grammes per cubic metre are deposited in the pipes and removed by washing; the remainder is carried into the cylinder, and passes out with the exhaust. From two to three grammes per cubic metre would seem to be the amount remaining in the gas after purification, or about 88 lb. daily in the 200 horse-power engine at Seraing. The proof that this dust causes no difficulty is found in the fact that the 4-horse power Simplex engine ran for four months without being cleaned. The 200-horse power engine has been working satisfactorily for eighteen months, and no difficulties have been experienced with the dust or with the ignition.

The Seraing Works were not slow to utilise the large store of motive-power thus placed at their disposal. Although they still adhere to the single cylinder type, and appear to find it the most suitable, engines with several cylinders are in contemplation in the future. Several large power motors have been constructed for use in their own works and elsewhere, and they are now making four Simplex engines for the Differdingen Ironworks, in Luxemburg. Each will develope about 700 indicated horse-power, or 550 brake horse-power; cylinder diameter, 1300 mm. = 4ft. 3in.; stroke, 1400 mm. = 4ft. 7in. These motors are intended to drive the blowing engines direct; the diameter of the latter is 1·70 metre = 5ft. 7in. Four engines of this type and size driving the blowers, and three to work the dynamos, or an aggregate of 3500-horse power, are now in course of erection at Seraing. All have valves of the Lang-Hörbiger or Riedler type, to increase the speed of the blowers. Fig. 3 gives

an outline drawing of the arrangement of motors and blowing engines adopted at Seraing. The Simplex single-cylinder engine is next the crank shaft, with the air pump behind, coupled direct to the back piston-rod. Fig. 3A gives a plan and elevation of four Simplex 500-horse power gas engines at the Cockerill Works for blowing the high furnaces. An engine is now being made for the Paris Exhibition of 1900. The valuable paper read by M. Greiner, the director of the Seraing Works, on the "Use of Blast Furnace Gas for Motive Power," at the Iron and Steel Institute in 1898, gives a clear view of the subject, and of the economy which may be expected from the use of these gases in the future.

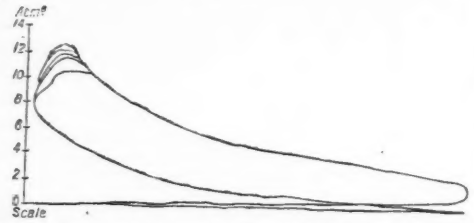


Fig. 4—DEUTZ OTTO GAS ENGINE—INDICATOR DIAGRAM

The well-known firm of the Gas Motoren Fabrik, Deutz, has also taken rapid advantage of this new field of enterprise, and more engines of the ordinary Otto 4-cycle type are made to drive with high-furnace gases than all other German motors put together. The Otto firm were indeed the first in the field in Germany, as they made the original 4-cycle experimental engine tested at Hörde in 1895, that led to the adoption of the larger Oechelhaueser with which such satisfactory results have been attained. Small experimental motors were also supplied by them to other places, and in many instances, as at Hörde, orders followed for much larger plants. The greatest difficulty this firm experienced was at Friedenshütte in Upper Silesia, where the furnace gases contained 30 per cent. of zinc dust. Two years ago they put up a 16-horse power experimental engine, which after many trials worked successfully. The results finally obtained after overcoming the difficulty were so satisfactory that a 1000-horse power plant has been ordered, consisting of five Otto engines, each developing 200-horse power, two of which have been running since January last. These engines work with great regularity, notwithstanding the dust with which the gases are charged, and drive the dynamos for the electric light without accumulators. Fig. 4 gives an indicator diagram taken from one of them.

Another important plant has been erected by the Gas Motoren Fabrik at Oberhausen, where there is a 600-horse power two-cylinder engine, and two of 300-horse power each. Here the gases are cleaned by passing them through three coke scrubbers and four purifiers filled with small coke, but no water is used. At Differdingen and at Seraing, water for washing the gas has also been found unnecessary. Fig. 5 gives a plan of a large 2000-horse power plant for electric light, consisting of two 1000-brake horse-power gas engines. Each has four cylinders side by side and opposite with two cranks, and drives the dynamo in the centre of the crank shaft direct. Thus there are in all eight cylinders for 2000-brake horse-power, equal to 250-brake horse-power per cylinder. This is the usual arrangement for large powers. An important plant has been supplied to the Düdelingen Iron works, in Luxemburg, consisting of one 500-horse power and two 1000-horse power motors, all driven with high-furnace gases; one of the three is already working. The Gas Motoren Fabrik Deutz have now on order gas engines with an aggregate of 12,000-horse power, for work with high-furnace gases in various places. The Société Otto (Paris) is also making three 600-horse power engines for high-furnace gases, each having four cylinders and four pistons, all working on to the same crank shaft through two cranks, or 150-horse power per cylinder—see Fig. 6. Fig. 7 shows a plan of a 300-horse power twin gas engine, made by the same company. These figures show the great development of the industry abroad.

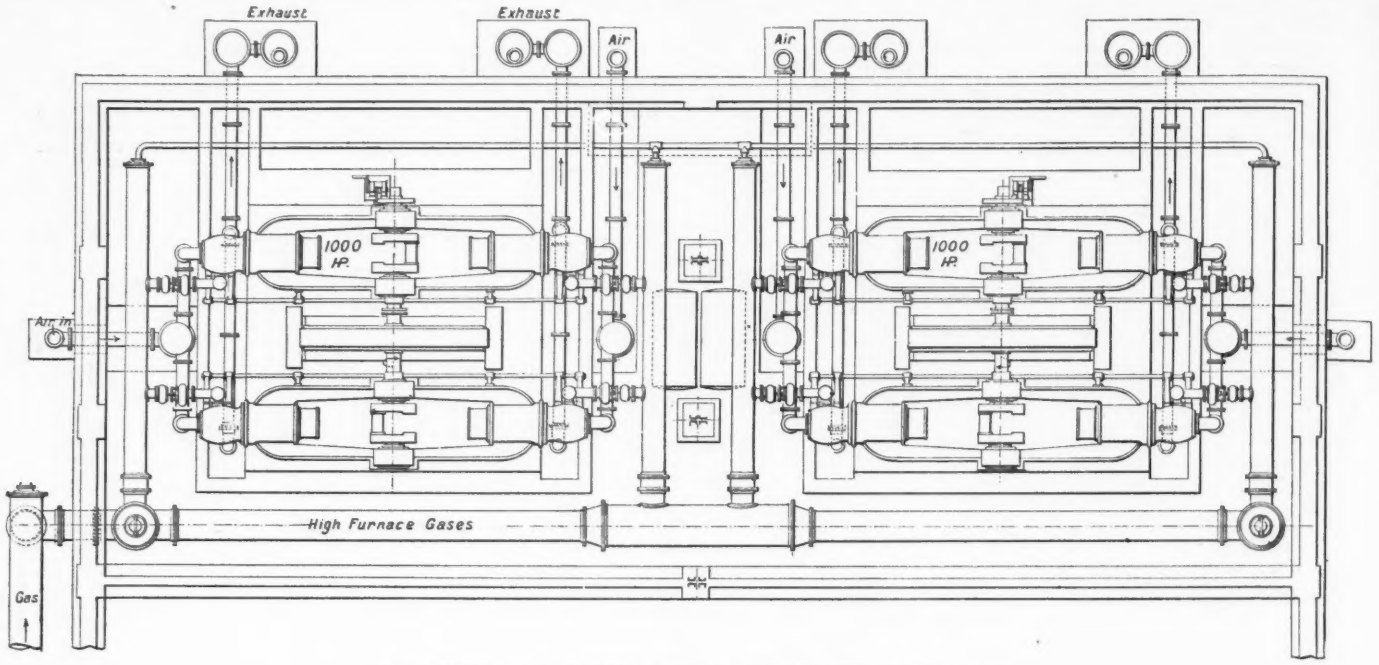


Fig. 5—1000-B.H.P. GAS ENGINES, MADE BY GAS MOTOREN FABRIK, DEUTZ

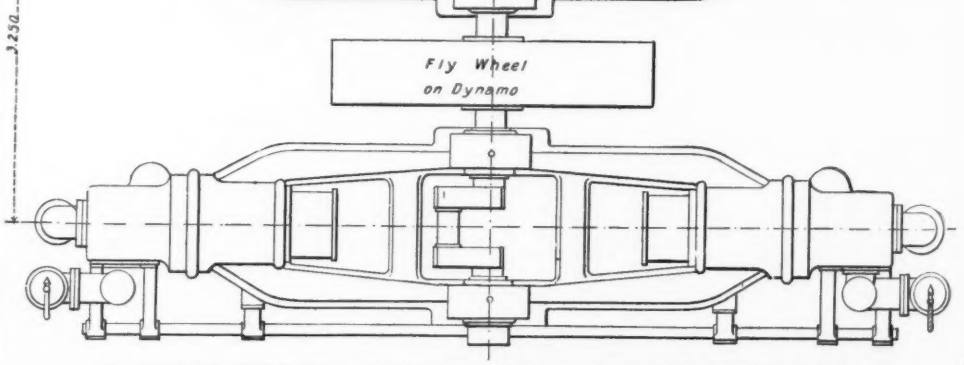


Fig. 6—600-H.P. GAS ENGINE, CONSTRUCTED BY CIE FRANCAISE DES MOTEURS A GAS

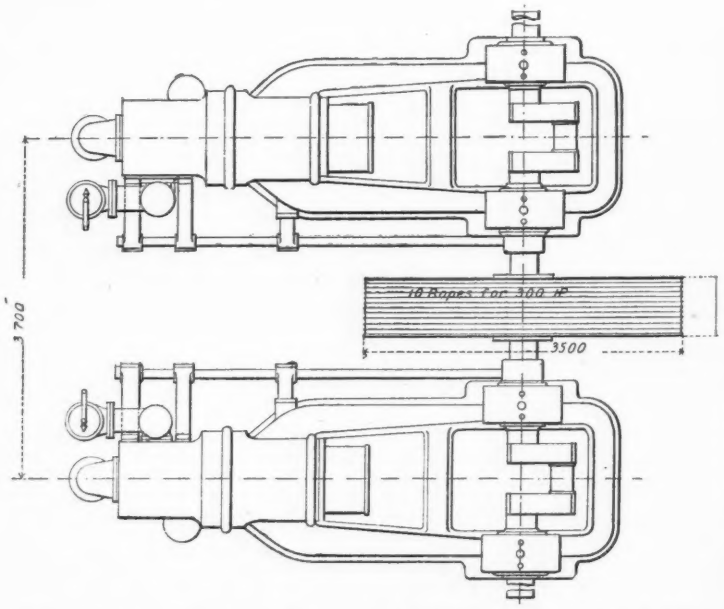


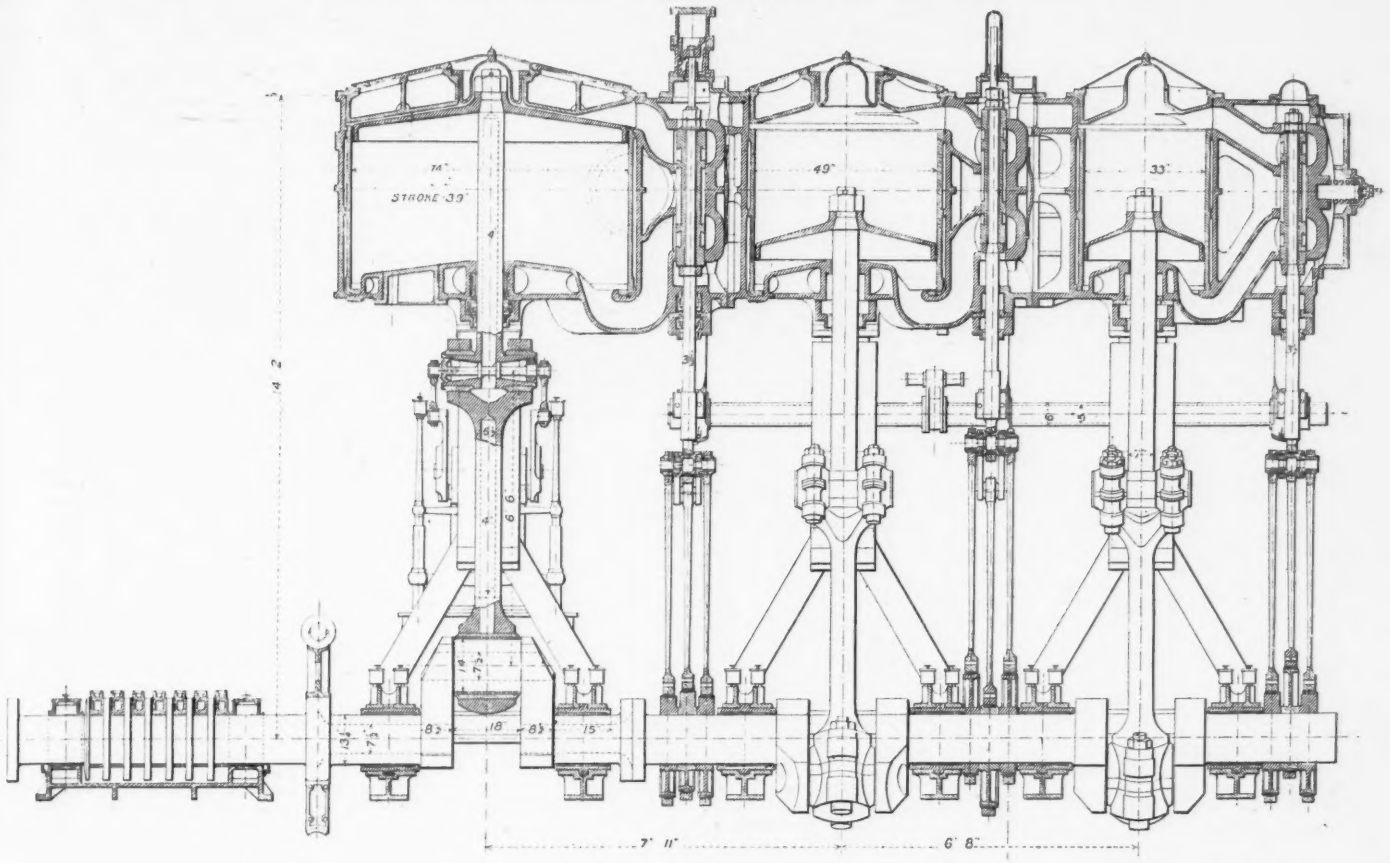
Fig. 7—300-H.P. TWIN GAS ENGINE, BY CIE FRANCAISE DES MOTEURS A GAS

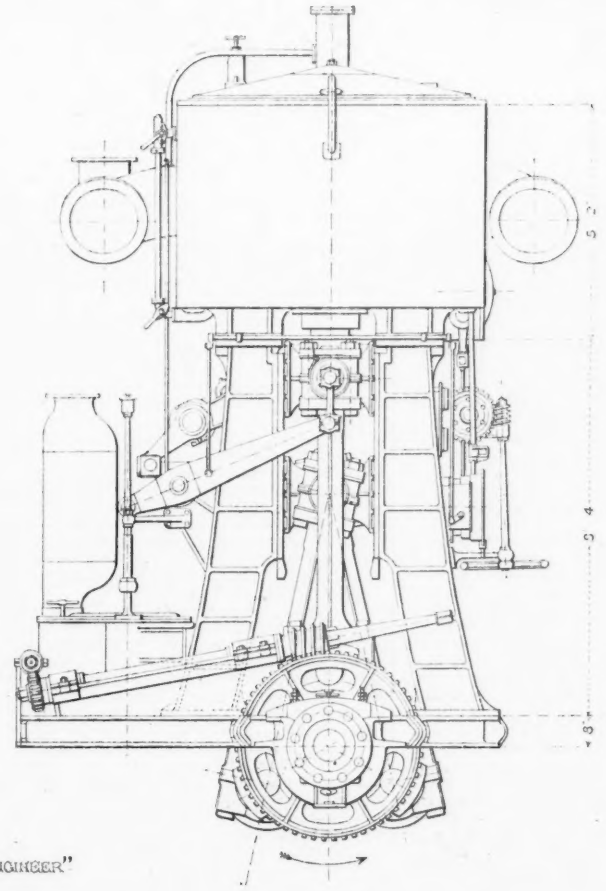
As regards the power developed, the Gas Motoren Fabrik Deutz do not in most cases consider it desirable to have more than 250-horse power per cylinder; thus a 500-horse power plant has two, and a 1000-horse power four cylinders. They consider that more regularity in working is obtained with this arrangement than if all the power is concentrated in one cylinder, where one misfire diminishes the work. The cost of a 1000-horse power motor varies but slightly, if made for one or for four cylinders, if great regularity of running is not required. But if, as in electric lighting, variations in work must be minimised as much as possible, the cost of a four-cylinder is only 60 per cent. of that of a single-cylinder motor.

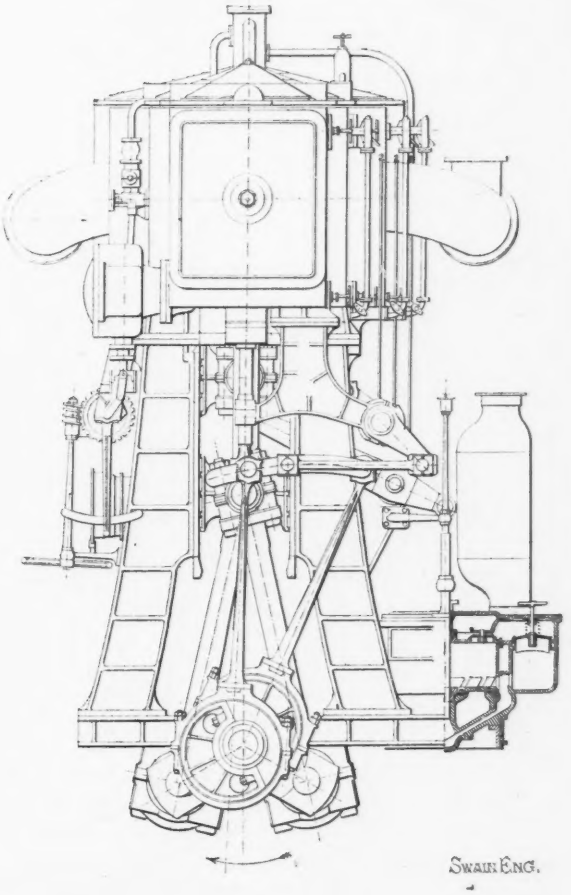
WITH the new year the National Telephone Company will introduce a new alternative scheme of rates, whereby the telephone service will be brought within the reach of many persons who have hitherto regarded the telephone subscription prohibitory. Very briefly, the new arrangement will be that any person can have the service laid on for £3 3s. per year, plus the Government royalty of 7s. per annum, and a payment of 1d. per three minutes' conversation for every message which he initiates on the exchange, no charge being made for messages in which he is called up by other subscribers. It is understood that this new arrangement is largely the outcome of the report of the Select Parliamentary Committee on the telephone question in 1898.

TRIPLE-EXPANSION ENGINES OF THE DUTCH CRUISER NOORD BRABANT

ROYAL ENGINEERING AND SHIPBUILDING COMPANY DE SCHELDE, FLUSHING, ENGINEERS







ENGINES OF THE DUTCH CRUISER NOORD BRABANT.

IN our issue of the 10th November we gave an illustration of the Dutch cruiser Noord Brabant, together with photographs of the engines and boilers, and a short description. We are now enabled to give the following further details of the engines and machinery of this vessel.

No piston valves whatever are used, all the main cylinder slide valves being of a flat double-ported equilibrium type, adopted by Mr. Martin, and invariably fitted by him, especially to high-pressure cylinders. They consist of a double-faced valve working between the cylinder port face and a balance frame having false ports, corresponding to and of exactly the same area as the cylinder ports. This gives an absolutely balanced and steam-tight valve, with practically no wear on the valve faces, and very little on the valve motion. This latter is proved by the light dimensions of the excentric rods, which are at the upper end 1⅝in. diameter, and near the strap 3½in. by 1¼in.

A further considerable saving is made in the total length of the cylinders, compared with those fitted with piston valves, being on an engine of this size from 4ft. to 6ft. With this same end in view, the exhaust from the low-pressure cylinder is taken out on both sides, and led by two separate exhaust pipes to the condenser. In later designs these two exhaust pipes are led into separate condensers, which can be worked single or conjointly.

The design of the valve gear, which is of the solid link type, is unique in so far as that there are three excentrics to each valve, in place of the customary two. The two outer excentrics work the valve in ahead gear, the middle excentric in astern gear. The former, taking hold of the link pins on the outside of the links, can be brought into line with the valve spindle when in full gear. The single astern rod takes hold of the link on a pin which is formed for half its length on each link and on the inner side. This rod cannot be brought into line with the valve spindle, and on this account has to make a longer stroke than the ahead excentric rods in proportion to the greater distance of the point of attachment from the centre of the link. The excentrics, however, although of different throw, are all made the same diameter

for the sake of simplicity and to reduce the necessary spare parts. The advantages claimed for this arrangement are:—Simplicity, all the excentric rods being straight, and, together with the excentric straps, interchangeable; a perfect distribution of stresses, the line of thrust of the excentrics, both in ahead and astern gear, being always in line with the valve spindle; and finally, the increased wearing surface provided in the ahead excentrics without unnecessarily increasing the astern surface.

The reversing engine is of the direct push type, which controls the gear perfectly and instantaneously without the use of a brake cylinder. The reversing levers are of cast steel, and independently adjustable. The weighshaft is 6in. diameter, bored hollow to such an extent that only ⅜in. of the metal is left, except where the levers are shrunk on, where the external diameter is increased. Notwithstanding the light scantlings of this shaft and its great length, not the slightest motion is perceptible on the levers, even when the engine is running full speed, this being a sure proof that very little power is absorbed in driving the slide valves. The shafting is of steel, and hollow throughout. The crank shaft is 14½in. diameter, with a 7½in. hole in the core. The cranks are set at equal angles of 120 deg.

The air pumps, which are of Edwards' patent type, thereby dispensing with bucket and foot valves, are 28in. diameter and 13in. stroke. During the trials they gave great satisfaction, and worked absolutely noiselessly.

The circulation of water in the condenser is effected by two circulating pumps, each with two engines, the cylinders being fitted with the same type of slide valves as the main engines. They were built by Henry Watson and Sons, at Newcastle-on-Tyne. The discs are 42in. diameter, and to overcome the difficulty sometimes occasioned by the discs working loose on their shafts, they are cast solid with the shaft, but with sufficient thickness of metal left to form a boss, to enable the shaft to be replaced by a new one when worn.

The main condensers, which are situated against the aft engine-room bulkhead, having a cooling surface of 6053 square feet each, are built of copper plates, No. 7 B.W.G. thick, both the shell and the covers being of the same material. To secure rigidity corrugations about 9in. pitch run circumferentially round the shell, the covers being corrugated radially and stayed in the centre. The inner surface is tinned all over, and altogether this construction, introduced by the makers, gives an extremely light and durable condenser. In this case the total weight, including tubes, is 8930 lb.; the weight per square foot of surface is 1·47 lb.

The auxiliary machinery in the engine-rooms comprises two duplex bilge pumps, two hotwell pumps, all of the same pattern, with steam cylinders 6in. diameter, pump barrels 8in. diameter; length of stroke, 12in. Steam cylinders are fitted with balanced slide valves. The hotwell pumps draw water from the hotwell and deliver through filters into a feed tank built against the forward engine-room bulkhead.

There is, further, a Hall's No. 7 refrigerating plant; two 30-ton evaporating plants by the Liverpool Engineering and Condenser Company, Limited, and two steam dynamos of 400 ampères, built by Willem Smit and Co., Sikkerveer, Holland.

For auxiliary purposes there is also fitted in one engine-room a condenser of 1000 square feet surface, of the same construction as the main condenser, and fed by a duplex combined air and circulating pump, having two steam cylinders of 8in. diameter, one double-acting air pump of 12in. diameter, and one double-acting circulating pump of 8in. diameter, the stroke of all being 12in. The main stop valve on the engine is of the flat balanced slide valve type, with quadruple steam ports to obtain a short stroke. This valve is moved direct by a hand lever or screw gear, which can be used when a fine adjustment is required.

The main steam pipes throughout are made in a manner introduced by Mr. Martin at these works some years back. They are of specially mild steel forged solid with the flange on, the same as an ordinary tunnel shaft with couplings. They are afterwards bored out by means of trepanning, and turned down to the required thickness. They are then bent cold to required shape, and where the bend is sharp the pipes are turned somewhat excentric, so as to compensate for the thinning of the metal due to the bending. To prevent distortion or flattening during this process, they are filled with cast iron discs held apart with washers, and strung upon a bolt passing through the centre. These discs are about ⅛in. smaller in diameter than the pipes, and are easily removed after the pipe is bent. The bending is performed under a hydraulic press in the same manner as with a copper pipe. This gives a practically indestructible pipe, all danger of riveted, brazed, or welded joints being avoided. There are no expansion joints whatever, carefully designed bends alone take up all expansion due to difference of temperature.

There are twelve boilers, all of the Yarrow type, and built at the Schelde Works. There are two stokeholds, each containing six boilers, fired fore and aft. The total heating surface is 25,720 square feet; the grate surface 456ft. The usual closed stokehold system has been abandoned for an open stokehold and Howden's forced draught. The main reasons which induced Mr. Martin to make this innovation were the desire to improve the ventilation and simplify the stokehold arrangement so far as possible, as well as economise coal consumption.

The ventilation is obtained by means of two large fresh-air down-come shafts in each stokehold, each having an area of 30 square feet, the hot air ascending in a casing built round uptakes into the concentric space between inner and outer funnels, this space being 21in. wide; and although the objection may be raised that it has the tendency to make the funnels look large, this is amply repaid by the very effective ventilation obtained. The forced draught is supplied by six fans, two of which are situated in the engine-rooms, where they help to improve the ventilation. Each fan is connected with two boilers, although there are valves in the air trunks by means of which any fan can be made to supply any boiler in the same stokehold. These fans deliver the air around the usual Howden hot-air tubes, which are grouped vertically on each side of the boiler steam drum. After being heated there, the air passes down on the front and back ends of the boilers, finally entering both above and below the fire-grate through regulating valves, which are adjustable from the front end of the boilers. In the boilers a firebrick wall is built up from the fire-grate to the under side of the steam drums, thus separating the two furnaces from each other, equalising the temperature and simplifying the firing of the boilers and clearing of fires. For the sake of simplicity all automatic feed arrangements have been dispensed with, the regulation of the feed-water being accomplished entirely by hand. In each stokehold are placed one Patterson pump and one Weir feed-pump. These both deliver into a common pipe, forming a circuit from which each feed check is supplied. There are no feed pumps in the engine-rooms whatever.

On the trials which took place last month, the whole of the machinery worked with perfect smoothness, whilst the improvement in the stokehold ventilation, as compared with the closed stokehold system, was the subject of general remark. On the four-hours' full-power trial a mean speed of 20·1 knots was obtained, the engines developing during that period an average power of 10,067 horses, at 143 revolutions, the maximum horse-power being 10,700, with a coal consumption of 2·05 lb. per indicated horse-power per hour, and on a thirty-hours' trial at half power, 1·85 lb.

NAVAL WORK IN CLYDE SHIPYARDS.

LAUNCH OF H.M.S. CRESSY.

Leaving out of account the Japanese battleship Asaki, of 15,200 tons, now nearing completion at the Clydebank establishment, the tonnage at present building on the Clyde for the British Navy—including vessels afloat undergoing completion—reaches the goodly figure of 110,000 displacement tons. That is rather more than one-half of the Admiralty tonnage on hand at all the private yards of the kingdom. In addition to the propulsive and accessory machinery for all this tonnage, there are also several important machinery contracts being executed by Clyde engineering firms for vessels under construction in Government dockyards. The work embraces cruisers, armoured and unarmoured; torpedo boat destroyers; twin-screw and paddle tugs; troopships and lightships—the whole making up the biggest total of warship work on hand at one time in the history of the shipbuilding industry on the Clyde.

The naval work at the Fairfield establishment progresses steadily. Including the first-class cruiser Cressy, which was safely launched on Monday, the 4th inst., the contracts on hand amount to approaching 55,000 tons displacement, or more than half the total tonnage at present in Clyde builders' hands. The contracts include, besides the 12,000-ton Cressy, a sister cruiser, the Aboukir, in the berth alongside, which is almost entirely plated, and is receiving her outside sheathing; a 14,100-ton armoured cruiser, the Good Hope, 500ft. long between perpendiculars, by 71ft. breadth extreme, operations on which, although practically only begun two months ago, have already resulted in over 1500 tons of material being worked into her structure; a 9800-ton second-class cruiser, the Monmouth, ordered in May last, whose keel is now being laid in the berth vacated by the Cressy; and two 30-knot torpedo boat destroyers, the Falcon and Ostrich, which are in frame and partially plated. Still another item of naval work on hand is a 6500-ton twin-screw troopship of high speed, to be named Hardinge, which the company is constructing to the order of the India-office. This vessel, whose keel and inner bottom are laid and frames partly erected, is 407ft. long, 50ft. 10in. beam, and 38ft. deep, and is to steam 18 knots on a six-hours' run at loaded draught. In sea-going trim she will draw about 19ft. of water and displace 6520 tons. The total indicated horse-power is to reach 8000, the engines being of the triple-expansion type, run at 110 revolutions.

The Cressy, illustrated on page 570, from photographs by Maclure, MacDonald, and Co., of Glasgow, is a sister ship to the Sutlej, launched on the 18th ult. from the Clydebank shipyard, gives name to the particular class of cruiser of which five others are being built—four on the Clyde and two at Barrow. The principal particulars of the Cressy and of her class were given in our account of the Sutlej in last issue, so that there is here no need to repeat. Some features in the Cressy, however, peculiar to herself, may be referred to shortly. As sent off the stocks the Cressy embodies a larger proportion of completed work than is usual at the launching stage, and this fact takes from the apparent forwardness of the Clydebank Sutlej. The race to completion of these sister vessels between the two renowned shipyards will no doubt be watched with interest. Extending from where the main broadside 6in. armour terminates to the vessel's extremities is 2in. nickel-steel armour plating. This specially hardened nickel-steel armour has been made by William Beardmore and Co., of Parkhead Forge and Steel Works. The Cressy is the first British naval vessel in which the Parkhead plating has been worked so extensively into the regular armour-plating scheme of the hull, although, of course, for a number of years past this enterprising firm have supplied 6in. armour plates of their special Harveyised manufacture for gun casemates and other purposes on board warships built for this and other nations. Altogether the Parkhead Company was entrusted with the making of over 2500 tons of side armour and casemate plating, &c., to be worked into the Cressy, Aboukir, Sutlej, and Implacable.

The Cressy, like the Sutlej, is to develop on trial, 21,000 indicated horse-power, estimated to propel the vessel at 21 knots. Little was said of the propelling machinery in our notice of the Sutlej, so that some particulars regarding the Cressy's engines and boilers may be given. The propelling machinery consists of two sets of triple-expansion engines fitted in two water-tight compartments, each set having four inverted cylinders, working on four cranks. The high-pressure cylinder is 36in. diameter, the intermediate 59in., and each of the low-pressure 68in. diameter, the stroke in all cases being 48in. The high and intermediate-pressure cylinders are each fitted with a piston valve, and each low-pressure cylinder with a double-ported slide valve with a relieving ring at the back; all the valves being worked by the usual double excentric and link motion gear. The reversing is effected by means of double-cylinder steam engines, with gear of the all-round type. Hand gear is also fitted. The crank, thrust, and propeller shafting is of forged steel, and hollow, supplied by the Parkhead Company. The propeller bosses are of gun-metal, fitted with four adjustable blades of manganese bronze. The main condensers are at the backs of the engines, and are cast brass of oval form, fitted with brass tubes, the condensing water being supplied by four centrifugal pumps of gun-metal, each fitted with independent engines. The feed, bilge, and hot-well engines are all independent, and separate from the main engines; steam for these and all other auxiliary machinery being supplied by a special range of steam pipes. The exhaust steam will be arranged to discharge to the auxiliary condensers, the atmosphere and the low-pressure receivers. There are two auxiliary condensers, each fitted with a circulating pump and a small air pump. List and Munn's patent feed-water filters will be fitted to prevent any impurities reaching the boilers. The vessel will also be fitted with the usual auxiliary machinery, viz., a complete distilling plant to supply fresh water to the boilers, and also for drinking purposes; three sets of engines and dynamos for producing the necessary current for electric lighting; two double-cylinder direct-acting engines, with the necessary gear for steering purposes; two complete sets of air-compressing engines and pumps, with the air reservoirs for charging torpedoes, and two vertical refrigerating machines of the cold air type, with the necessary cold chamber for ship's provisions. Steam will be supplied by an installation of thirty water-tube boilers having economisers, all of the latest Belleville type. The boilers are arranged in four groups, each group fitted in a water-tight compartment. They are designed to work at a pressure of 300 lb., valves being fitted to reduce the pressure to 250 lb. at engines. Pumping engines are fitted in each stokehold to supply air to the furnaces and combustion chambers, and the necessary air for the stokehold ventilation will be supplied by large fans. Fans will also be fitted for the engine-room and ship ventilation.

The launch of the Cressy was effected without a hitch in the presence of a great gathering of spectators, both inside and outside the shipyard, the releasing and naming ceremony being performed by Lady Alice Boyle. The Fairfield Company afterwards entertained a large company of ladies and gentlemen at luncheon in the drawing-office. In the unavoidable absence of Sir William G. Pearce, Bart., Dr. Francis Elgar, F.R.S., presided, and in the course of the toast, "Success to H.M.S. Cressy," said she represented a very admirable combination of all the fighting qualities necessary in a cruiser. She was a great improvement in several important respects upon the first-class cruisers Diadem and Argonaut, recently built at Fairfield. So far as both offensive and defensive powers were concerned she was an advance, and she was also an improvement in point of speed. The dimensions were very little different. The Cressy was only 5ft. longer than the Diadem, and had 6in. more beam, but she would be loaded over a foot deeper, and have 1000 additional tons displacement. That increase had enabled the designer, Sir William White, to make important improvements in the fighting qualities which would distinguish the Cressy class from their predecessors. The engine power was increased sufficiently to give greater speed than the vessels of the Diadem or the Argonaut class had. The Cressy would be half a knot faster than the Diadem, and a quarter of a knot faster than the Argonaut. The next thing done with the additional available displacement was to make a material addition to the defensive power of the ship, and that was perhaps the most important improvement in the design. The original idea of a cruiser was, as naval officers would tell them, a ship of great offensive power, that depended chiefly for defence on a speed sufficiently great to enable her to show her heels. In time that idea was modified. It was found that the guns could not be worked unless they were protected, and the guns of the Diadem's and the Argonauts were consequently protected by armoured casemates. The Cressys also had the armoured casemates, but, in addition, the whole of the central portions of the ship were protected by armoured citadels of 6in. steel at the sides, and 5in. steel bulkheads at the ends. In this the ships of the Cressy class seemed to be developing backwards to the battleships of twenty-five or thirty years ago, which had protection of much the same kind, but in reality the armour and protection of the Cressy was superior in fighting value to those of the Hercules, Sovereign, and Alexandria. Not only had the defence of the Cressy been greatly increased, but most naval men would agree that the offence had also been strengthened by the substitution of one 9·2in. gun forward and aft, instead of the two 6in. guns which the other ships carried.

The Cressy forms the last contribution to the Royal Navy that will be made this year from Clyde yards, and of the other naval work on hand a few particulars may be interesting. Since March 31st last the works and business of the renowned Clydebank shipyard—originally established at Clydebank in 1872 by James and George Thomson, and since 1890 known as the Clydebank Engineering and Shipbuilding Company, Limited—have been carried on, on behalf of John Brown and Co., of the Atlas Works, Sheffield. This firm took possession of the shipyard and other properties on September 2nd last, since which date the business in all branches has been carried on by it, the purchase money having for most part been paid over. These celebrated works, it need only very briefly be stated, consist of the shipyard, engine works, boiler shops, and auxiliary departments, all of modern construction, fitted throughout with the latest appliances for efficiently turning out battleships and other war vessels, mail steamers, and cargo boats of the highest class. Over £280,000 have been spent on new machinery and other important extensions during the past four years. Not counting the vessels launched this year, the number of vessels of all kinds built at Clydebank has been 165, of which 116 were merchant vessels, and 49 vessels of war, 28 of the latter being for the British Government. The largest merchant vessels produced were the Paris and New York, each of 10,700 tons, and the largest warship the Jupiter, of 14,900 tons displacement.

There are at the present time uncompleted contracts on the books for over £3,000,000, including two first-class cruisers for the British Admiralty, the Japanese battleship Asahi, and five large Atlantic liners, which are progressing satisfactorily.

The berth vacated by the Sutlej on the 18th ult. will now be occupied by the heavily-armoured cruiser Leviathan, of 14,100 tons displacement, sister ship to the Good Hope referred to above as on hand at Fairfield. Other naval work on the stocks embraces the Bacchante—sister ship to the Sutlej and the Cressy—and two torpedo boat destroyers of 30 knots speed. In the wet dock adjoining the shipyard and engine shops there lies beside the Sutlej, the Japanese battleship Asahi, which is expected to be ready for her steam trials in April next. The Asahi, which is the second warship built at Clydebank for the Japanese Government, is the heaviest ever constructed on the Clyde, her displacement tonnage, as complete, being 15,200 tons. As is well known, she is a sister ship to the Shikishima, recently completed by the Thames Shipbuilding Company. Her length, extreme, is 405ft. 6in.; breadth, 75ft. 2½in.; and depth, 43ft. 7½in. The engines, also supplied by the Clydebank Company, are of the three-cylinder triple-expansion type, and consist of two sets, each of which is expected to develop 7500 indicated horse-power, or a total of 15,000 indicated horse-power. The boilers are of the Belleville water-tube type, with economisers, and twenty-five in number. The speed will be between 18 and 19 knots. When completed, the Asahi, like the Shikishima, will undoubtedly be one of the most formidable battleships afloat.

The London and Glasgow Shipbuilding and Engineering Company, Limited, so far as naval work is concerned, is but indifferently employed. Apart from two paddle tugs for the Admiralty, each of 410 tons, and one of which has been

launched, only one naval contract is now on hand for the British Government, viz., the 9800-ton cruiser Monmouth, of the modified Cressy class, sister ship to the Bedford, above noticed as being under way in Fairfield. About a month ago the second-class cruiser Hyacinth, 5600 tons, similar to the Fairfield, Hermes, and Highflier, left the builders' wharf and the Clyde, and she has since undergone her official trials from the Devonport dockyard. This is the third vessel delivered by the London and Glasgow Company this year to the British Admiralty, the others being the gunboats Thistle and Dwarf, each of 700 tons, handed over in September last. This company, indeed, since Mr. J. W. Shepherd became the managing director, has taken quite a prominent place amongst naval shipbuilders, for the Hyacinth is the eighth vessel delivered for the Navy by the company, the displacement of these totalling 70,000 tons, while the horse-power of machinery is 59,000 indicated, and all of this machinery has been designed and successfully passed through trial by Mr. William Morison, the engineering manager to the London and Glasgow Shipbuilding and Engineering Company.

Bow, MacLachlan, and Co., Thistle Works, Paisley, who continue extremely busy with orders for their patent steering gears, hoists, and other specialities—many of which are for naval ships now being built in the dockyards and private establishments—have also on hand in the yard of McArthur and Co., which they themselves carry on, three powerful tug steamers for the Admiralty. The vessels, which are 170ft. in length, and propelled by twin screws, are to attain a speed of 18 knots,

THE SMITHFIELD CLUB SHOW.

THE hundred-and-first annual show of the Smithfield Club was opened at the Agricultural Hall, Islington, on Monday last, and closes to-night—Friday. As is customary, nearly all the leading manufacturers of agricultural implements and builders of traction and oil engines have acquired space for the exhibition of their products, which on each succeeding year appear to become more and more stereotyped in design, so much so that, in framing a report, it becomes annually more difficult to write anything with regard to the exhibits which has not been written many times previously. The ground floor, that is the space under the galleries, is as usual taken up largely by the builders of engines, while the galleries themselves are occupied chiefly by farm implements. Taking the steam engine builders first, these include Mr. William Allchin, Northampton; Aveling and Porter, Limited, Rochester; Brown and May, Limited, Devizes; Charles Burrell and Sons, Limited, Thetford; Clayton and Shuttleworth, Lincoln; William Foster and Co., Limited, Lincoln; John Fowler and Co., Limited, Leeds; Richard Garrett and Sons, Limited, Leiston; E. S. Hindley, Bourton; Richard Hornsby and Sons, Limited, Grantham; J. and F. Howard, Bedford; Marshall, Sons, and Co., Limited, Gainsborough; P. J. Parmiter and Co., Tisbury; Ransomes, Sims, and Jefferies, Limited, Ipswich; Robey and Co., Limited, Lincoln; Ruston Proctor, and Co., Limited, Lincoln; Robinson and Auden, Limited, Wantage; W. Tasker and Sons, Limited, Andover; E. R. and F. Turner, Limited, Ipswich; Wallis and Steevens, Limited, Basingstoke; and Woods and Co., Stowmarket. The larger portion of these firms exhibit engines of standard types, but there are a few features in connection with some of the engines to which attention may be briefly called. Perhaps the most novel engine exhibited is Parmiter's agricultural engine and road-maker combined. This engine is made with a central driving wheel 4ft. 6in. diameter and 4ft. wide. This wheel is placed on the driving axle, and enables the engine to be used on soft land or bad roads, over which an ordinary traction engine could not be taken. In fact, it acts as a roller on bad roads. The front part of the engine resembles generally the ordinary traction engine. When desired, a wagon can be fixed above the roller wheel, thereby giving the latter greater adhesion. We illustrated one of these engines in THE ENGINEER of March 25th, 1898.

Amongst Richard Garrett and Sons' exhibits is a portable engine, fitted with Pickering governor on top of the steam chest; the valves being arranged inside the chest give the whole a more compact appearance. A number of highly-finished engines of various types are shown by Robey and Co. Amongst them is a portable engine, in connection with which we noted that the main shaft and cylinders are carried on wrought iron brackets, which are riveted to the boiler shell, thereby obviating the use of bolts and nuts in the steam space. Ransomes, Sims, and Jefferies, Limited, exhibit, amongst other things, a new 8-horse power compound road locomotive, mounted on springs. The gearing, shafts, axle, and driving wheels are made of extra strength to withstand the heavy strains these engines are subjected to when hauling excessive loads on hilly and bad roads. The gearing is securely boxed in to prevent the access of dirt and to reduce the noise. This firm also show a high-speed vertical engine. The reciprocating parts are accurately balanced, and all the bearings are provided with screw adjustments, and can be got at without difficulty. The lubrication of the working parts is automatic and continuous, sight feed arrangement with valve adjustment instead of syphons being provided in all cases. The engine is fitted with an automatic expansion shaft governor, which controls the cut-off automatically by varying the throw of the excentric. Ruston, Proctor, and Co., Limited, have on their stand an effective display, including single-cylinder and compound portable engines, horizontal and vertical engines, and a thrashing machine. In the newest type of portable engine built by this firm the cylinder is mounted on a box pattern seating of steel riveted to the boiler; this seating being open top and bottom, and communicating with the steam jacket space of the cylinder. Steam passes direct from the boiler to the jacket space round the cylinder barrel, and thence to the top of the cylinder where the stop, throttle, and safety valves are arranged. By this plan dry steam is ensured and the cylinder maintained at a constant high temperature, and condensation reduced to a minimum. Besides the stop and throttle valves being placed above the steam chest, they are much less affected by dirt carried over with the steam. The working barrel is formed by a separate liner forced into the cylinder casting. A finishing thrashing machine made by Ruston and Proctor has in connection with the shakers an excentric motion which is worthy of notice.

Since the last Smithfield Show the Darby land digger has been somewhat modified in design, with, it is claimed, considerable improvement. In order to facilitate steering the triangular carriage forming the framework of the appliance is now carried on a rocking wheel. The rotary digging tools formerly employed, we notice, have given way to thin circular steel discs, made so as to be easily attached and detached. The main frame of the apparatus has also been improved so as to further facilitate its connection and disconnection from the engine. Clayton and Shuttleworth's stand includes agricultural and portable steam engines, oil engines, and a thrashing machine. Although in none of these are there very important novel features, yet close observation reveals certain improvements in detail. For instance, the 8-horse power portable engine has now a new bored guide for the crosshead, a steam-jacketed cylinder, and an improved arrangement of the cylinder fittings. The starting lever, instead of being placed on the front of the boiler, is now placed at the side, so that, although easily accessible, it is nevertheless put where it cannot well be accidentally moved. This firm further shows an 8-horse power traction engine, with certain modifications in design, which render it adaptable to the Darby digger attachment. Attention should be called to a detail of the thrashing machine, which has been improved. This is a new device for securing the scaffold doors to the cross boards. It consists of a link and lever mechanism, which is readily unfastened, and yet when secured is perfectly rigid.

John Fowler and Co., Limited, exhibit steam ploughing engines, road locomotives, and agricultural traction engines. The exhibit comprises representative engines of some of the varieties they are constantly manufacturing. They also exhibit a road locomotive, mounted on springs and fitted with three speeds, of the type which has been used during the past two years at Aldershot and Salisbury Plain by the Army Service Corps. With this type of engine, loads have been continually taken from Aldershot to Salisbury Plain in a day. The engines will run with safety up to eight or ten miles per hour, and carry sufficient water for a run of seventeen to twenty miles. To attain this result, the consumption of water is only twenty to twenty-four gallons per mile, and the fuel consumption is correspondingly small. Seventeen of this firm's traction engines have already been purchased by the British Government for transport operations in South Africa. For examples of inexpensive portable steam engines and boilers suitable for the farm and similar situations, Mr. E. S. Hindley's stand usually furnishes some objects worthy of notice. The exhibits this year, although we should imagine not high priced, give the impression of substantial construction and sound finish. A somewhat new departure made this year is a small high-speed vertical compound engine, with cylinders 6in. by 10in. by 6in. stroke. This engine is very compact, and would suit a small electric lighting plant. Crank shaft governors, as usually fitted by Mr. Hindley, give excellent diagrams.

The exhibits on Aveling and Porter's stand are remarkable for the excellence of the workmanship and the sound proportions followed in the designs. The firm claims, and we believe justly, that in these respects they follow the best locomotive practice. It may be observed here that they also are sending engines to South Africa to the order of the War Department.

Oil engines, which annually form a more imposing feature of the show, are shown by Clayton and Shuttleworth; Crossley Brothers, Limited; Richard Hornsby and Sons, Limited; J. and F. Howard; Edward Humphries and Co., Limited; Ruston, Proctor, and Co., Limited; the Trusty, Engine Works, Cheltenham; Blackstone and Co., Limited; Allen and Barker, Taunton; J. B. Petter and Sons, Yeovil; and the Campbell Gas Engine Company, Halifax. Crossley's exhibits include a 15-brake horse power portable oil engine, all the working parts of which, including the crank, are boxed in, so as to be suitable for farm work.

In the implement section, Coleman and Morton, of Chelmsford, show a newly-designed spring tine cultivator. The spring tines are of special construction, highly tempered, and made in one piece, the upper part being continued and bent round to strengthen the back. The tines are carried in two rows on a steel frame, made to rise and fall as may be required, in strong slotted brackets at each side. They may be adjusted to any distance apart that the work may require. The wearing points are reversible. In this machine the frame is always level, and the tines therefore work at a uniform depth, which is regulated at will by a hand lever, which is also used to raise the tines before turning.

J. and F. Howard, of Bedford, have an effective exhibition of ploughs of various kinds, including a three-furrow implement for potato planting, manure covering, and ridge splitting, steel zigzag harrows, steel grass harrows, grass mowers; haymakers and horse rakes are also exhibited.

E. R. and F. Turner, Limited, of Ipswich, show specimens of steam engines, called the "John Bull," which has not been seen at a Smithfield Club Show before. There are two of them, three and six nominal horse-power, with cylinders 5in. by 7½in., and 7in. by 10½in. They are fitted with the Pickering type of governor, but we are informed that all except the smallest size can be supplied with the Turner-Hartnell automatic expansion-shaft governor. The object of this engine, we are told, is to meet the demand for small cheap engines, which, nevertheless, must be strong, durable, and easily fixed.

STEAM TRIALS OF THE BATTLESHIP GOLIATH.

THIS battleship, whose first keel plate was laid on the slip on which she was built at Chatham Dockyard on January 4th, 1897, and whose construction was so considerably delayed by the engineers' great strike that she was only put into the water at the end of last March, has now after the vicissitudes often met with in first engine trials, finally completed those which were contracted for by the builders of her machinery, John Penn and Sons, late of Greenwich.

As we gave in our issue of February 24th last a fully illustrated description of the fine twin-screw propelling engines with which the Goliath has been fitted by Messrs. Penn, we need here only repeat that the two sets are of the three-cylinder inverted triple-expansion type, each set driving a four-bladed screw propeller 16ft. 9in. diameter; the collective horse-power to be developed by them upon an eight hours' full power trial being 13,500 indicated; steam being supplied by twenty Belleville boilers working at 300 lb. pressure per square inch.

The steam trials carried out were three in number—two of thirty hours' continuous steaming, the first at 2700, and the second at 10,250 indicated horse-power, both of these being to test the coal consumption at these powers. The third trial was to be a continuous eight hours' run at full speed, or 13,500 indicated horse-power.

For the purposes of the first of these trials, the ship left Sheerness on September 27th, and proceeded down the Channel, the engines working well for eighteen hours of the steaming time, till being off the Isle of Wight, when the joint of the high-pressure cylinder cover of the starboard engines gave out, and the set had to be put out of running until the fault was made good, the port set of engines continuing the running in the meantime, and developing 1350-horse power. After making good the defective jointing, &c., occupying seven hours, the thirty hours' trial was proceeded with to a satisfactory finish, the mean results attained being as follows:—With the ship practically on an even keel—her water draught being 26ft. forward and aft—her boilers under a working steam pressure of 236 lb. per square inch, and the starboard and port engines running respectively at 65·8 and 65·6 revolutions per minute, the mean indicated horse-power realised by them was 1467 and 1340, or a total of 2807, which exceeded that contracted for by 107-horse power. This power was developed by a coal consumption of 1·73 lb. per indicated horse-power per hour, the speed of ship realised being 11·7 knots in the same time. This trial was completed on Friday, September 29th, the ship having been abreast of the Start, when she resumed her trial run with both sets of engines.

On the 10th October the second coal consumption trial of the Goliath at 10,250-horse power took place to the westward of the Eddystone, commencing at noon of that day, and finishing on the evening of the 11th, the mean results attained at it being:—With the ship at the same water draught as on the first trial, and her boilers working at a pressure of 273 lb. per square inch, the starboard and port engines made 99·5 and 101·7 revolutions per minute, and developed 5160 and 5253-horse power respectively, or a total of 10,413 indicated horse-power, being 163 in excess of the contract, the coal consumption being 1·54 lb. per indicated horse-power per hour, and the speed attained by the ship 17·1 to 17·32 knots in the same time. The stokeholds were under no air pressure during either of these coal consumption trials.

Some defects having been discovered in the pump arrangements of the engines of the Goliath on the completion of the foregoing described trials, the ship was delayed till these were rectified before proceeding on the eight hours' full power trial which took place in the Channel on November 22nd, when the following satisfactory results were attained:—With the ship at the same water draught as on the previous trials, and steam at a boiler pressure of 290 lb. per square inch, the revolutions of the starboard and port engines were 108·1 and 109·8 per minute, and the power developed by them 6998 and 6920 respectively, or a grand total of 13,918 indicated horse-power, being 418 in excess of that contracted for; an eminently satisfactory result, both engines and boilers having worked remarkably well, the coal consumption on the trial having been 1·91 lb. per indicated horse-power per hour, and the speed of the ship in the same time 18·4 knots.

As a battleship, or any class of warship, is seldom called upon to exceed the normal rate of steaming attained by her on a thirty hours' coal consumption trial at four-fifths of her full power, the results given above show that the Goliath, as regards her capabilities in this direction, can claim to hold first place among the sister battleships of her class. Of the principal officials present at her trials, the Admiralty was represented by Mr. J. H. Ellis, staff engineer; the Chief Constructor of Chatham Dockyard by Mr. J. Wright; and the machinery contractors, John Penn and Sons, by Mr. W. B. Dixon.

As a special interest is now being taken in the application of the latest improved Belleville boilers to warships, we give below in tabulated form the results of practical tests made at the boiler works of John Penn and Sons at Deptford with two of the boilers of the Goliath, to determine funnel base temperatures, coal consumption, feed-water used, evaporation, &c., from which results we leave our interested readers to draw their own conclusions.

With the final completion of the machinery of the Goliath and its acceptance by the Admiralty authorities, we believe the world-renowned firm of John Penn and Sons, marine engineers, retires from the scene of its labours, and it must be gratifying to the remaining members of the old staff to remember that in no case in its long history has a serious mishap occurred, or a job been thrown on its hands through bad performance.

Test Trials of Two of the Boilers of H.M.S. Goliath, made by John Penn and Sons, at Deptford.

Date of trial	August 11th, 1898	August 12th, 1898
Duration of trial	4 hours	4 hours
Type of boiler	8-element Belleville	9 element Belleville boiler with economiser
Number of boilers in use	one	one
Total area of fire grate in use	48·5 square feet	54·6 square feet
Total heating surface in use	1549·5 square feet (995·2 blr., 554·3 ecr.)	1766·3 square feet (1119·6 blr., 646·7 ecr.)
Heating surface.—Grate area	31·95	32·35
(B) Steam pressure in boilers	298·75 lb.	300 lb.
Pressure of air in boiler-room	·875in. of water	·875in. of water
Furnace air pumps:—	(Vacuum at base of funnel).	
Revs. per minute	85	81·68
Pressure of air	12·625 lb. per sq. in.	12·56 lb. per sq. in.
Temperatures:—		
Gases at base of funnel	366·25 deg. Fah.	523·75 deg. Fah.
(A) Feed-water	58 deg. Fah.	58·25 deg. Fah.
Feed-water on leaving economiser	246·31 deg. Fah.	255·25 deg. Fah.
Coal:—		
Total used per hour	1445 lb.	1688 lb.
Per sq. ft. of grate per hour	30 lb.	30 lb.
Description	Welsh, from Penllyn, Merthyr	
Approximate thickness of fires	About 5in.	About 5in.
Interval between firing each furnace	3 minutes	3 minutes
Feed-water:—		
Total used per hour	14,273 lb.	16,779 lb.
Per sq. ft. of heating surface per hour	9·211 lb.	9·5 lb.
Per pound of coal	9·877 lb.	10·243 lb.
Equivalent evaporation to dry saturated steam:—		
Per sq. ft. of heating surface per hour:		
Based on (A) and (B)	9·211 lb.	9·5 lb.
From and at 212 deg. Fah.	11·274 lb.	11·618 lb.
Per pound of coal:		
Based on (A) and (B)	9·877 lb.	10·243 lb.
From and at 212 deg. Fah.	12·089 lb.	12·527 lb.
Evaporative power of the coal used (from and at 212 deg. Fah.), and how ascertained	14·22 lb. (by Thompson calorimeter)	
Manner in which steam was disposed of	Escaped to atmosphere. Funnel blast. Air blower and feed pump.	
Efficiency of boiler	·851	·88

A PROPOSITION to regulate the water levels of the Great Lakes by a dam on the River Niagara has at intervals been brought to the notice of the Americans. Mr. George T. Wisner, member of the United States Deep Water Commission, is an advocate of this scheme, and has recently read a paper on it.

TRACTION ENGINES IN SOUTH AFRICA.

THE general public, not familiar with the facts, regard, we believe, the traction engine as a very unwieldy, slow-moving machine, which must have good roads to run on. In point of fact, the modern traction engine is a very powerful locomotive, the design of which is the result of long years of experience acquired under the most arduous conditions. It is made—and it must be made—of the very best materials it is possible to obtain, and it is able to get across most difficult country in a way that can only be comprehended by those who have seen one at work. Even when the ground is so bad that the driving wheels cannot get a good grip, a long wire rope is laid out in front, anchored to a tree, a large boulder, or, failing these, to iron or wooden stakes driven into the ground, and then, by the aid of its windlass gear, the engine will warp itself along to firm ground. Even rivers can be crossed where a ford exists; in fact, it is not easy to say what the nature of the country is that cannot be traversed by a traction engine. The engines can exert about 120 indicated horse-power, they weigh about 18 tons, and their powers of endurance are marvellous. It is no matter for wonder that our Government have sent out numbers of engines to South Africa at the instance of Col. Templar, R.E., Director-General of Steam Transport. The value of these for transporting stores of all kinds will be better appreciated, we fear, further on, when the South African horse fever, due in December and January, begins to play havoc with "unsalted" horses.

In a recent impression we illustrated the traction plant obtained from Messrs. J. and H. McLaren, of Leeds. We now illustrate, on page 567, the engines sent out by Fowler and Co., of the Steam Plough Works, Leeds. Our group of engravings is particularly interesting, because it represents the development which the engines have undergone to fit them for colonial work. Traction engines have played an important part in Africa before now, notably on the Uganda Railway works. Mr. Fowler and his partners, holding that it was desirable not only to sell engines, but to find out by personal experience what they could and could not do in Africa, and what was wanted in the way of improvement, sent out Mr. Robinson as a commissioner to obtain the necessary information. We are indebted to Messrs. Fowler for the following summary of Mr. Robinson's diary:—

"I arrived in South Africa in the early part of 1897, when rinderpest was raging in that part of the world. Having had many years' experience with traction engines and steam ploughing machinery, at home and abroad, for my employers, John Fowler and Co., Limited, of the Steam Plough Works, Leeds, this firm sent me out specially to travel through South Africa and collect information with regard to the conditions under which the above class of machinery would have to work.

"On arriving in Cape Town, I went direct to Honeynest Kloof. This is a small place on the Kimberley Railway. I left the railway at this point and took Cape cart for about a forty miles' drive into the interior. I crossed the Free State border about three miles from Honeynest Kloof Station, and it was here where I first came into contact with the rules and regulations laid down for preventing the spread of rinderpest. My Cape cart was stopped at the border, and I had to carry my luggage some distance and engage another cart in the Free State. I travelled in the Free State for some three weeks, arriving at Bloemfontein about the end of that time, where I had the pleasure of starting the first traction engine which turned wheel in that State. President Steyn kindly consented to go to the railway station, crack a bottle of champagne on the wheel of the engine, and make a speech in Dutch relative to traction engines and steam ploughs in his State. I may say that during the time the engine was being erected at Bloemfontein, President Steyn granted me a very pleasant interview at the presidency, and suggested that my firm should use their best endeavours to introduce their steam ploughing machinery into the Orange Free State. He said that one trait of the Dutch character was that they did not care to adopt any new-fangled arrangements from descriptions given in catalogues, newspapers, &c., but that with them seeing was believing. He very kindly offered to carry the first set of tackle for nominal rates over the Free State Railways, should my firm send a set out. I may say here that I sold a set of tackle in this State, and it has been sent out and put to work there. I showed President Steyn some photographs of our military traction engines hauling big guns, and endeavoured to induce him to order one for the State Artillery. He did not fall in with this idea, and remarked that heavy artillery would be of little use to his Government at any time. Going back to the trial of the traction engine, Bloemfontein made a general holiday for this event. A military band played us through the town, and several of the Free State Mounted Police were in attendance to keep the crowd clear of the engine. The wagons not having arrived from England, I got six ox wagons, and, by means of a length of wire rope fixed beneath them, connected the lot to the engine, using the dissel booms simply as rigid bars to keep the wagons from running into each other when going down steep gradients. On these wagons I had about thirty tons of coal in bags, and in addition to this about 100 Boer farmers mounted the wagons, making probably another five or six tons. We ran the engine through the main streets of the town, and then, by special request, we crossed a very bad spruit outside the town, where President Steyn had driven in front of us to see us cross. Hundreds of the Boer population had assembled here to see us stick fast, as feeling was running very high at the time against everything English. We crossed this spruit in good style without the least hitch, when the Boers assembled could not refain from giving us a good cheer.

"A short time after leaving Bloemfontein I had the pleasure of meeting President Kruger at Pretoria. My meeting was special and arranged for the afternoon, which was a very unusual time to interview the President. The usual time for visitors to see him was from 5.30 to 7.30 a.m. I waited upon him at the Presidency, having with me a gentleman who could converse in Dutch. The President cross-examined me at some length with regard to the machinery turned out by my firm. Previous to my visit he had been down to the Transvaal border to inspect one of my firm's double engine steam ploughing tackles, which appeared to astonish the old man by the amount of work it got through per day. With the President were six members of the Raad. My catalogue, as it was opened at each page, was handed to the President, who appeared to express his satisfaction in short grunts, and handed the catalogue round to each member present, when the next page was opened and the same thing gone through again until they had come to the end of the book. Evidently the members of the Raad present were farmers, as they were much taken with the steam plough shown in the catalogue, attached to a traction engine and hauled direct. They considered this to be the nearest approach to their ox-drawn ploughs; in fact, the President gave me a verbal order to send such a steam plough out for his own use. Although I consider nothing existing is able to compete with the double-engine system of steam ploughing, I must say here that I have done some very good work in the Transvaal on the open veldt, breaking in virgin land with one of my firm's compound traction engines and a direct-drawn plough. Where the farmers are too poor to purchase the larger set of tackle, a lot of work can be done by the direct-drawn plough. Where circumstances will admit of furrows 1000 yards long or more being cut, a considerable loss of time would result from turning in short lengths. Such an engine would, of course, be available for the other work on the farm also. After the veldt had once been broken in by steam power, the operations in following years by animal power would be much lighter.

"During my travels in the Transvaal I came across a new engine made by my firm, and also a new thrashing machine by a leading English house. The engine and machine had been erected by a fitter, an expert, I believe, in rock-drilling machinery. On my arrival they were about to start the machine, but many of the parts had not been put in; for instance, the elevator cups, riddles, &c., had been omitted. Fortunately I had with me a suit of Khaki, which I donned, and assisted him to complete the erection of the machine and start it. I also fed the machine for an hour or so, to show the Kaffir how to do this work. I daresay I should have continued my lessons a little longer, but, when feeding, a snake about 2ft. long went into the machine with one of the sheaves, so I thought the Kaffir had better take his turn then. I make the foregoing remarks to show how essential it is that special skilled men should be sent out or kept in the country for starting special machinery, otherwise the makers of such machinery are frequently wrongly blamed for failure of the machinery in question to perform its full duties.

"From the Transvaal I went to Kimberley, and spent some time in the city of diamonds, residing at Mr. Findlayson's Central Hotel there—a very comfortable place indeed, where every man from the Old Country is always made welcome. I had the pleasure of seeing several of my firm's double-engine steam ploughing tackles at work on the diamond fields harrowing the blue ground which is brought up from the mines and spread on the floors or fields to be disintegrated. Naturally I solicited an order for some more of this machinery, but was informed by the chief engineer that another set was on its way out from England.

"From Kimberley I went to Bulawayo. At the time of my visit the railway in course of construction ended at Palapye in Khama's land. Messrs. Pauling kindly gave me permission to travel on their construction train from Mochundi to Palapye. Although I had to lie on a truck load of steel sleepers with some dry grass, rugs, &c., this was a luxury compared with my after experience travelling up in wagon from Palapye to Bulawayo. I spent some time in Bulowayo and district, residing at the Charter Hotel there.

"From Bulawayo I went to Salisbury, some 310 miles distance, and travelled with Mr. Zeederburg's coach—or, perhaps, I had better call it a wagon—carrying her Majesty's mails. On this journey we averaged about a mile and a quarter per hour continuous travelling night and day. This will give one some idea of the speed at which her Majesty's mail rushes through Mashonaland. Frequently when crossing rivers the passengers had to dismount and assist the wagon over the passes or spruits. When travelling through this part of Africa to Mashonaland and Matabeleland, one gets the impression that the land is much better adapted for agricultural purposes than in the Transvaal or Orange Free State. For miles the track passes through high grass—in some places 6ft. and 8ft. high—and the country is also well wooded; but in other parts of Africa I have seen scarcity of water, and abundance of dust and sand appears to be the curse of the country. I may say that it was during the dry season when I went through this district. I spent some time in Salisbury and district. The Mashonas at the time were fighting, and I witnessed one of the actions some distance from Salisbury.

"I am pleased to say that my firm were not only the first to send traction engines into the Free State, but also into Matabeleland. It was rather amusing to have the remarks of the Matabele people interpreted about the first traction engine—one of my firm's compound—which arrived in Bulawayo. They said it was a monster brought from the white man's country, but it did not like working, as it shrieked (whistled) every time it had to move, and it had got the fever very bad, as the white man had to keep continually pouring medicine into it (oiling).

"Before returning home, I had the pleasure of testing my firm's engines in various parts of the country, both on short and long runs, and have come to the conclusion that there is a future for properly-designed traction engines to meet the particular requirements obtained in the various districts, and working in conjunction with animal haulage. For instance, a system of transport could be established, say, between Bulawayo and Salisbury, by traction engines working on good sections of the route, hauling a train of the ordinary African ox wagons, say, making journeys of ten to twenty miles. When arriving at a sandy tract, the wagons could be detached from the engine and taken across a strip of sand—which frequently extends from two to six miles—by animals, the engine taking back empties or loaded wagons, as the case might be, on its return journey. By this arrangement, a financially successful transport service could be carried on in many parts of South Africa."

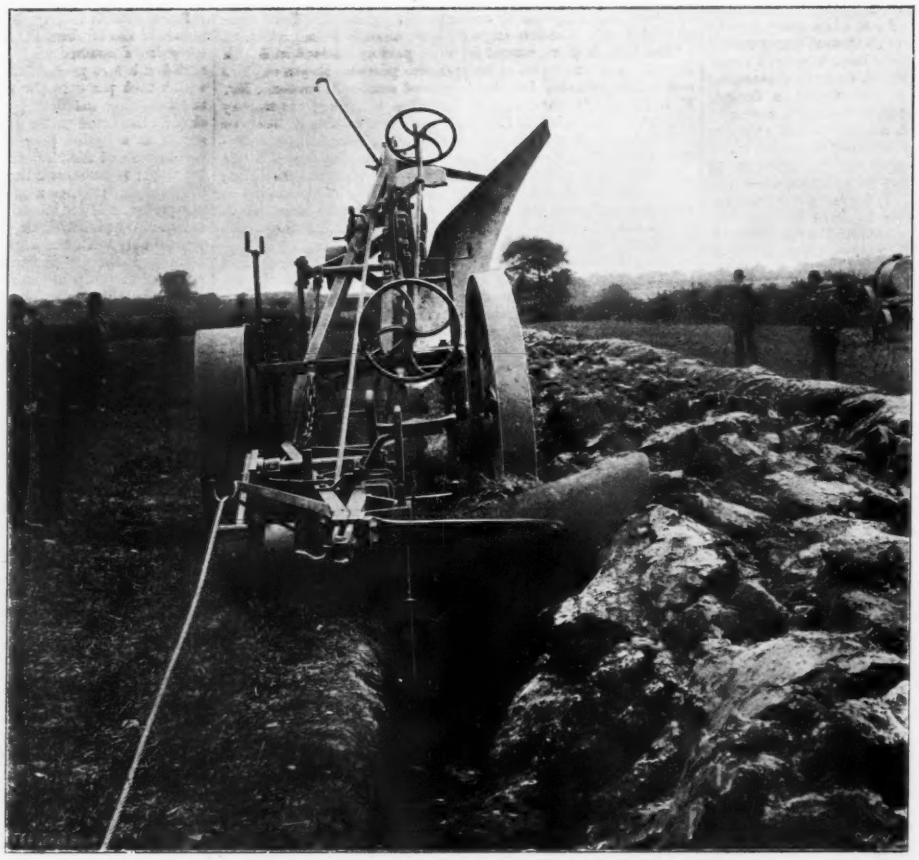


Fig. 5—TRENCHING PLOUGH

Mr. Robinson suggested several improvements in matters of detail to his firm, which have been adopted. Among the first engines sent out were those for Koffyfontein, illustrated by Fig. 1. They are mounted on springs on the hind end only, have compound side-by-side cylinders, 6¼in. by 11¼in. diameter by 12in. stroke, boilers specially made for South African coal, according to Cape and Natal railway practice, for 180 lb. per square inch working pressure; tanks to hold enough water for twelve miles' run with a load of 25 tons, or with the engine for a load of 43 tons, and with special wheels. After Mr. Robinson had returned from South Africa, the designs were modified in detail, as shown by Fig. 2, principally with a view to protection from dust storms, &c. Many engines have been supplied of this type to the Free State and to the Transvaal.

In February, 1898, the Crown Agents for the Colonies bought two of these engines for working twenty miles in front of the head of the Uganda Railway. The work these engines did was very satisfactory, and resulted in an order being placed with Fowler and Co. for two similar engines with certain modifications, which engines were sent out in March, 1899. On August 12th, 1898, the engineer reported that one of the first engines had done most satisfactory work. In July it travelled 344 miles, and transported all rations for the earthwork coolies, besides hauling out the heavy cast iron cylinders that were used for culverts. It also hauled to the site the corrugated iron pipes used for temporary openings, and earthenware pipes, and, in addition, supplied water to coolies working between Derajani and Kibwasi. For this duty the engines had proved themselves very well suited, and, owing to the great losses in bullocks and mules, they have been of great assistance in advancing the work.

TRACTION ENGINES FOR SOUTH AFRICA

MESSRS. JOHN FOWLER AND CO., LIMITED, LEEDS, ENGINEERS

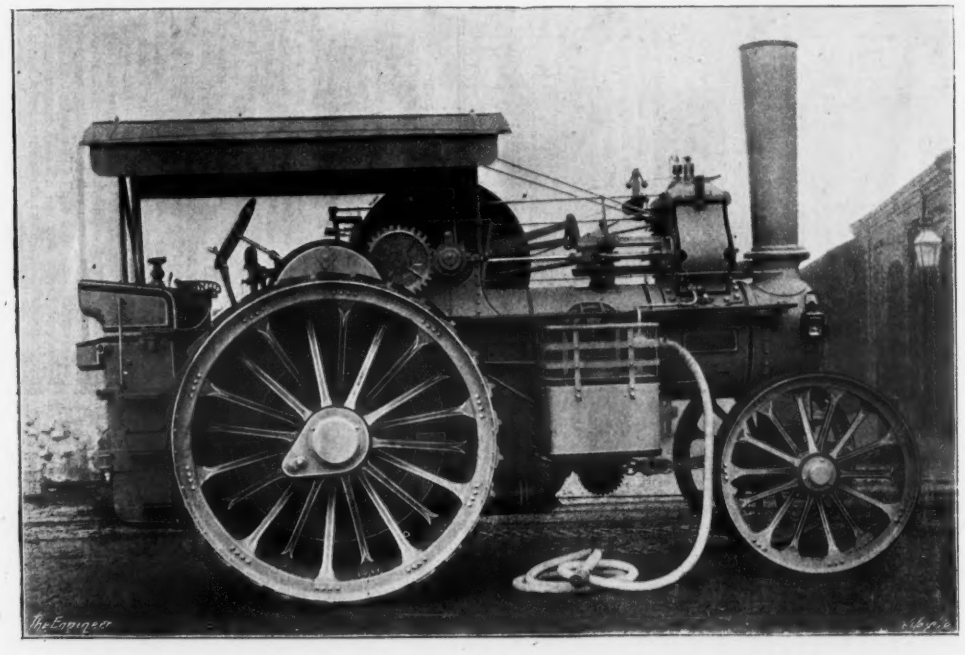


Fig. 1—FOR KOFFEEFONTEIN

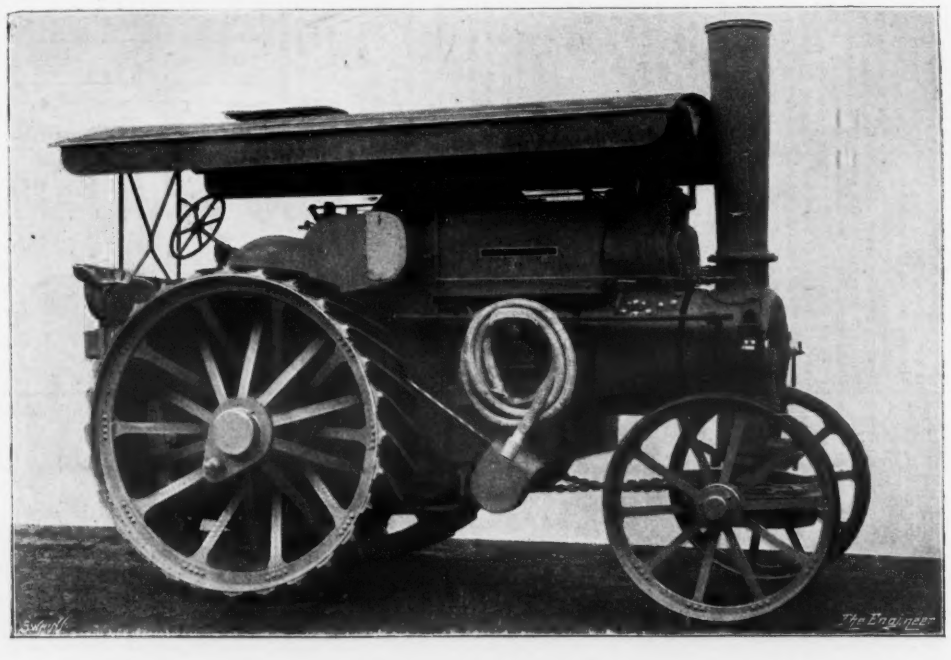


Fig. 2—FOR THE TRANSVAAL

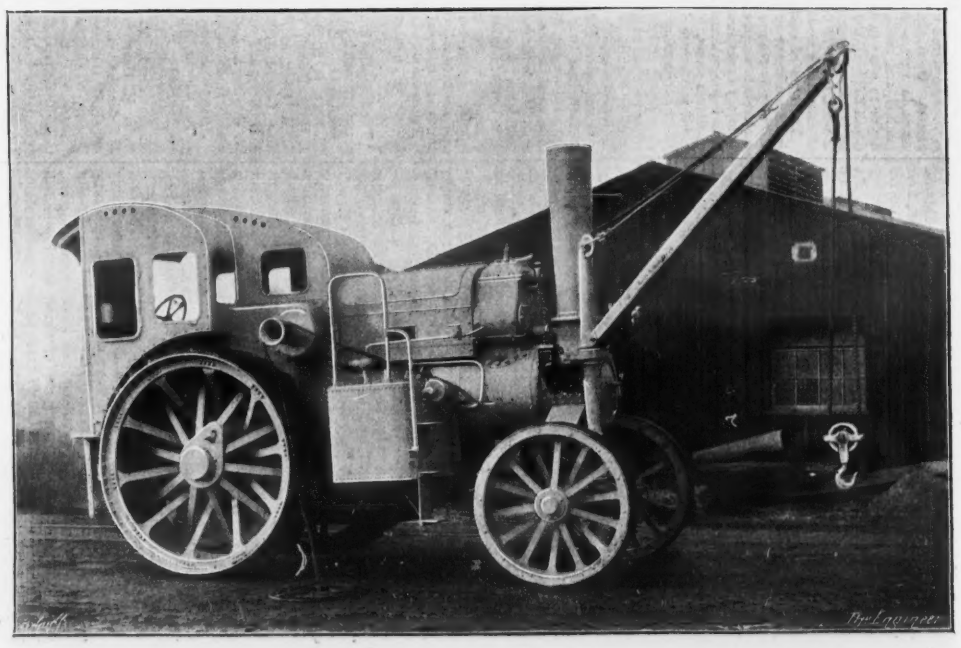


Fig. 3—FOR THE UGANDA RAILWAY

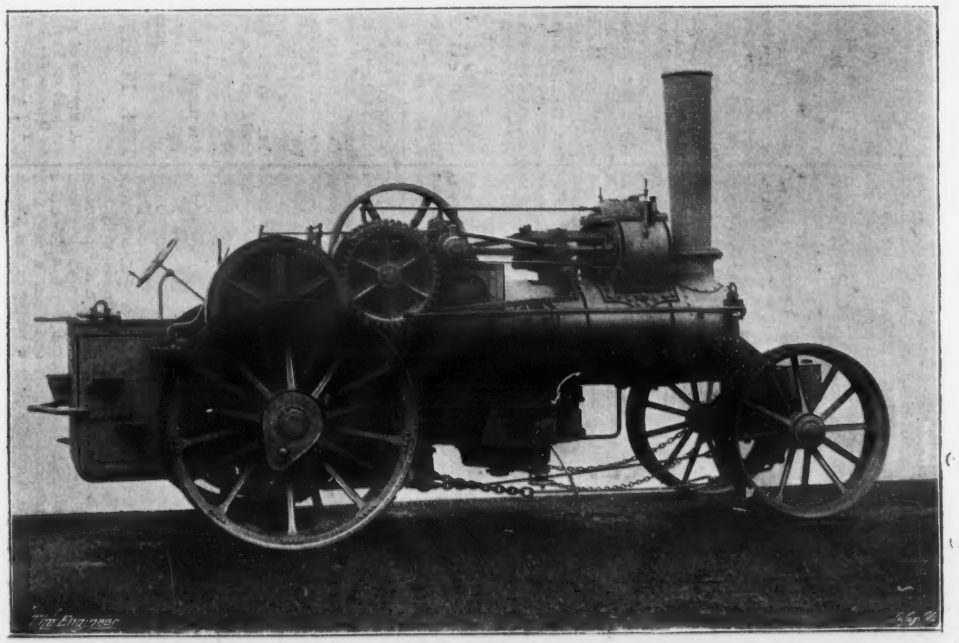


Fig. 4—PLOUGHING ENGINE

On the 9th September, 1898, the engineer reported:—"The trial they have had during the last month has been very satisfactory, and I would now recommend that two more engines, with the equivalent wagons, should now be sent out."

On the 6th October, 1898, the engineer reported that the traction engines had proved "most serviceable in sending up rations, &c., and moving the camp, and large bodies of men can now be kept twenty miles beyond railhead. One traction engine ran 202 miles in eighteen running days, and the second one 266 miles in twenty-two running days."

The modifications above referred to required for the second order were, increased tank capacity, dust covers, iron enclosed cab, for protection against branches of trees—for these engines work through the bush—petroleum firing apparatus, in addition to coal and wood firing, and a 15 cwt. Bollard crane, shown on Fig. 3, and a five-ton jib crane.

In August, 1897, the firm delivered to Aldershot one of its latest road locomotives, fitted with spring gear on both hind and front wheels, and also fitted with three road-speeds, arranged by means of patent locking gear, so that only one speed can be put into gear at a time, and to carry sufficient water for a twelve-mile run; the load, including engine, was to be 60 tons on ordinary roads. It was tried in the Long Valley at Aldershot, and passed all its tests satisfactorily. With this engine it was proved that stores could be taken from Aldershot to Salisbury Plain—a distance of about sixty miles—in a day. That it could easily travel at the rate of eight miles an hour, and when necessary to get out of the way of troops at the rate of twelve miles an hour, and that at the slowest speed it dragged a gross load of 80 tons on the level, and would travel seventeen miles without fresh supply of water.

The engine is also fitted with an independent donkey pump for either filling tanks, water troughs for horses, or its own boiler. It is also fitted with a water lift by which its own tanks or troughs or independent tanks can be filled. It was also used for driving centrifugal pumps and electric dynamos, and for travelling with a captive balloon. Three more engines of this type were supplied by the firm to Aldershot for the Army Service Corps in July and August, 1898. Three more engines were ordered before the war broke out, for delivery in August and September, 1899, also for the Army Service Corps, and were delivered up to time.

When war appeared probable, eleven engines were ordered early in October, 1899, for delivery by November 14th. All these engines were sent in to time. Two of these were Army Service type; three were South African type; four were the largest traction and winding engines, made for ploughing, like Fig. 4. These last are fitted with cylinders 8in. and 14in. diameter by 14in. stroke, and will easily give off-120 horse power. They are fitted with horizontal drums, and 500 yards of $\frac{3}{4}$in. wire rope on each drum. Two have, in addition, drums with 1000 yards of rope on each drum. They will be used for winding loads over rivers and swamps, and up precipitous places. They are also to pull the trenching plough, Fig. 5, which cuts a furrow 30in. deep on the solid, and 30in. wide. This enormous work is done by putting a pulley on the plough and anchoring one end of the rope so that the pull on the plough is doubled. These ploughs are usually used for vine and tree planting. In the Transvaal they will be used for making shelter trenches, and also for making the ditches at each side on roads. Two of these ploughs were also supplied.

Vans of various kinds have been supplied by the firm to go with the engines. We have ascertained that up to the 27th ult. twenty-four engines have either been shipped or are in course of shipment to South Africa. Of these seventeen have been made by John Fowler and Co., and seven by three other makers—J. and H. MacLaren, Charles Burrell and Sons, and Aveling and Porter. Of the seventeen, four are traction engines for winding, three are road locomotives of South African type, ten are road locomotives of Army Service Corps type, described above. Of the latter ten, six were supplied direct by Fowler and Co., one was bought by the Government from Mr. Allen, of Oxford; one from Mr. Wagstaff; and one from Mr. Froud, of Henley; all these engines being of the same type and supplied within the last twelve months. Inquiries were made of other customers to whom this type of engine had been supplied, but they would not part with their engines.

BOILER EXPLOSIONS.

DURING the twelve months ending June 30th, 1899, 52 preliminary inquiries and 16 formal investigations into the cause of boiler explosions have been made under the Acts of 1882-90. These 68 explosions caused the death of 36 persons, and inflicted injuries on 67, making a total number of casualties which is far higher than last year. This is largely accounted for by the disastrous effect of the accident at Barking, which killed 10 persons and injured 23. It cannot, therefore, be taken as indicating any general increase in neglect or mismanagement on the part of steam users.

Out of the total number of explosions only 47 were of steam generators, the remainder being accidents to steam pipes, valve chests, cast iron vessels, and so on. Of these 47 boilers, 14 were of the marine type, 14 vertical boilers, nine locomotive type, seven Cornish and horizontal cylindrical; and three water-tube boilers. The total number of persons killed was 27, and the total number injured 56. If the casualties at Barking are subtracted from this it will be seen that the list of accidents from steam-generator explosions is not very high. It is interesting to note that in a very large proportion of them the part of the boiler which gives way is the fire-box. Thus, out of the 47 cases before us no less than 22 failed in this part, or, if we subtract the boilers which have no fire-boxes, quite 50 per cent. fail here. Amongst the locomotive boilers five fire-boxes were ruptured, and in one case a stud was blown out of the fire-box. In the remaining three cases, plugs for stopping tubes were blown out, each accident resulting in casualties. Among marine boilers only two accidents occurred in the furnaces, but among vertical boilers 10 certainly failed in the fire-box; one was blown overboard, and therefore presumably the crown of the box had given way; and the three remaining explosions were failures of small importance. The flues of five Cornish type boilers gave way, and in the remaining two cases of horizontal land boilers, one of which was egg ended, the shell ruptured. Out of the 47 cases under consideration, 29 were not inspected. In 12 instances where the inquiry had been completed, the owners were blamed for negligence, as a rule, as regarded inspection, and had to pay costs varying from £15 to £125. The following abstracts from the report are worth attention:—"Many safety valves are loaded by means of a spring in tension or compression, the pressure being regulated by a screw. When the pressure at which the valve is required to blow off is ascertained, the fitting of a washer or ferrule, to prevent any further screwing up of the spring, affords a very simple and inexpensive method of preventing the overloading of the safety valve. Absence of this fitting has resulted in numerous explosions; the Courts have frequently pointed out the necessity for it, but, unfortunately, this simple precaution is not generally adopted. In three of these cases the Court has called attention to the matter. The case dealt with in Report No. 1173—the Barking explosion—is one of the most disastrous explosions which has occurred within recent years, resulting in the loss of 10 lives, injury to 23 persons, and enormous damage to surrounding property, and the Court observe that properly-qualified persons were not appointed to manage the works—an observation which was emphasised by the neglect of the manager to see that a washer or ferrule was placed under each of the compressing nuts of the safety valves, in order to prevent the nuts being screwed down so as to produce an improper load upon the safety valves. The Court found that the explosion was owing to the safety valves having been screwed down to a pressure exceeding that of 200 lb. per square inch by the neglect of the mechanic who was employed to adjust them, and they held the owners responsible for his neglect, and also for neglecting to appoint properly-qualified managers of their works. The explosion last referred to occurred in engineering works which were formerly under the management of a retired ship-master, succeeded by a naval architect, neither of whom possessed the qualifications of an engineer, and the naval architect was succeeded by a mechanic, whom the Court held to be unfit to be manager of engineering works. They were of opinion that a consulting engineer should have been called in from time to time. As in previous years, several of the explosions have been due to ignorance, but the Commissioners will not accept this as an excuse for neglecting to take proper measures to ensure that a boiler is being worked under safe conditions, and it may be useful to repeat their decision in this respect, viz.:—That if a person for the purpose of his business chooses to use steam appliances which, if neglected, become a source of very grave danger, not only to himself but to others, he must, in the event of an explosion, be taken to have known that it was his duty to ascertain that they were kept in good condition; and, further, that if he was not able to ascertain this himself, it was his duty to have called in a competent person from time to time to examine the boiler, to ascertain if it was fit to be worked at the pressure required."

THE INSTITUTION OF CIVIL ENGINEERS.

STUDENTS' MEETING.

A MEETING of students of the Institution of Civil Engineers was held on Thursday evening, 30th November, the President, Sir Douglas Fox, in the chair.

The President delivered a short address to the students, and Mr. Lewis H. Rugg, Stud. Inst. C.E., then read a paper on "Bridges for Light Railways," of which the following is an abstract:—

Bridges for light railways may be defined as single-track bridges, the span of which does not as a rule exceed 100ft., and on which a rolling load of not more than 1½ ton per foot run would be applied. Cheapness in design is necessarily an important factor, as a few costly viaducts will seriously increase the cost per mile of the railway. For foreign countries and abroad it has been found cheapest to adopt deck-plate girders up to 50ft., and beyond this through-open girders. A 40ft. bridge of the former type is briefly referred to, together with the calculations for the main girders. Open girders of one system are recommended, as the stress in various members can be calculated by the graphical method, and results of great accuracy obtained; the relation of depth to span in these girders varies with each bridge; if the depth be great, the distance of centre lines of girders will have to be increased owing to construction gauge. An open girder for 3ft. 6in. gauge of 60ft. span is considered, and the graphic method of calculating stresses described.

The sizes of members should be so proportioned as to have as small a number of sections as possible, especially when prompt delivery is required, and in the case of girders for abroad it is desirable to adopt channel sections for both top and bottom chords, as injury in shipment is thus avoided; the size and section of all tires is proportioned in accordance with the ratio of maximum to minimum stress.

All joints were riveted, the stress allowed on rivets being taken at 80 per cent. of the stress allowed on the member it unites for shop rivets, and 66 per cent. for field rivets. If the number of rivets required at each joint be small, gussets should be dispensed with by slightly increasing the depth of section in the top and bottom chords.

Cross girders and railbearers were calculated by assuming the greatest load that could be brought to bear upon them, while the wind-bracing follows the rule of 1½ ton per 100 square feet of exposed surface, no extra stress being allowed for in the bottom chord unless the lateral load exceeds 30 per cent. of the live and dead loads; a ½ ton per foot run was allowed for bridges crossing some rivers in West Africa, to allow for swollen streams and floods, which often carry in their course large trees and bush at great speeds. Expansion arrangements of a simple sliding surface are recommended, although other methods, such as rollers and rockers, are briefly referred to.

A discussion followed, in which Messrs. Skinner, Bushell, Dormor, Leader, and Risdon took part.

The following is a list of candidates who have passed the October examination, 1899:—

Studentship.—H. B. Bain, J. A. Balfour, E. A. St. G. Bedbrook, W. Bent, G. S. Boulton, E. M. Bull, E. O. Cole, E. H. Dean, J. G. Dickinson, W. F. Dugdale, J. H. Fennell, G. D. Farwell, F. D. Flint, A. Fox, G. M. Greaves, S. Jacobs, E. Josselyn, R. A. Legard, J. M. Mackay, C. C. F. Mackenzie, B. G. Meaden, J. D. Morgan, J. G. Y. D. Morgan, R. H. Morrison, L. Oulton, W. Patrick, F. J. Rodwell, C. H. Rudge, W. J. Shelley, C. G. K. Sladen, G. Stow, N. Wilkinson, D. H. Windsor.

Associate Membership.—R. D. T. Alexander, A. L. Anderson, J. A. Balfour, H. W. Barker, E. A. Baldam, R. Carpmael, W. Clapham, W. R. T. Cottrell, J. M. Cowan, C. A. S. Day, A. R. Dyer, W. H. Elce, E. H. Essex, G. D. Farwell, E. Ferro, M. B. Field, T. F. Firr, S. H. Garnett, W. P. Gauvain, H. E. H. Harrison, L. J. Hunt, E. L. H. Jones, T. J. McDonald, J. S. Marshall, T. L. Matthews, J. E. Montague, M. B. de Olszewski, G. G. Ommanney, P. à M. Parker, C. H. Reynolds, C. G. Rocher, W. C. Shaw, W. J. Shelley, C. G. K. Sladen, R. H. H. Stanger, P. C. Stewart, R. A. Swarbrick, N. S. P. Trimingham, C. K. Trubshaw, S. T. Watts, J. H. Williams, D. H. Windsor, J. S. Wise, A. L. Yockney.

THE appointment of instructor in electrical engineering and design at the Northampton Institute, Clerkenwell, has been given to Mr. E Kilburn Scott.

THE RAILWAY ROLLING-STOCK REQUIRED BY AN ARMY CORPS.

IT is a truism that war requires all sorts of communications, both by land and water, to accumulate its necessaries and accelerate the movement of troops. But warfare has always had to find the creative power in itself, to invent a leading principle for every way in which it is to move, and, among all the means that stand at its disposal, to give the preference to the simple and usual above the unusual and complicated. Railroads must be included in the former; for they are undoubtedly the passive forces of a country which can be most advantageously turned to account for purposes of active hostilities. Nevertheless, the control of them does not prove a universal means for victory; the best recipe for the latter has been, and at all times will be, a well-disciplined army joined to a resolute and skilful generalship. But as Marshall Sax wrote, "The secret of war lies in the legs," so now-a-days the secret lies in the skilful employment of existing lines of railroad from the strategical, if not from the tactical point of view. It will be as well, however, to at once differentiate clearly between the two sets of circumstances, strategical and tactical. Under the first must be included the mobilisation and concentration of an army, and once these preliminaries to a campaign have been effected, there comes the question of a well-organised train-despatch conveying provisions and munitions of war, together with a system of expeditious circulation which will retard, if not altogether avoid, the inevitable exhaustion of the country where the troops are stationed. Again, when fighting has actually commenced, railways have still an important strategic rôle to play, notably in carrying to the rear sick and wounded and bringing to the front reinforcements. For transporting fighting bodies of troops, however, which brings us to the tactical sense, their importance is not so great. Infantry alone can profit by them to a certain extent, but only to a certain extent. Past experience, in fact, goes to prove that on double-track lines time is not saved unless the number of miles to be covered is more than two and a-half times the number of thousands of bayonets, and on single-track lines unless the number of miles is over three and a-half times the number of thousands. In South Africa the railroads are practically all on the single-track system. For concentration purposes it must be remembered that the number of trains which can be despatched in one day from a strategic entraining centre is limited by the number which can actually be loaded successfully within that time. The great length of the rail journeys in South Africa, however, will necessitate an abundant supply of rolling stock, for there is little chance of the trains first despatched being returned as "empties" until two or three weeks have elapsed. The following table gives the composition of troop trains as laid down by the army regulations for the various tactical units:—

Nature of train.	Engines.	Brake vans.	First-class.	Composite.	Second or Third-class.
Half batallion of infantry	1	1	1	—	17
Half battery of artillery	1	1	—	1	9
Squadron of cavalry	1	1	—	1	5
Field company, R.E.	1	1	—	1	7
Total for a division	40	40	18	22	317
Total for an army corps	189	189	58	131	1166

Nature of train.	Horse boxes	Cattle trucks.	Carriage trucks.	Store trucks.	Total vehicles, including engine.
Half batallion of infantry	2	3	5	—	30
Half battery of artillery	2	10	8	—	26
Squadron of cavalry	6	16	1	—	31
Field company, R.E.	4	5	6	—	25
Total for a division	115	275	3 0	—	1157
Total for an army corps	583	1471	1526	35	5378

These figures show that the transport of an army corps, from the rolling-stock point of view alone, is a task of considerable magnitude, involving as it does the services of no less than 189 locomotives and 5189 vehicles. Again, all the troop trains are very heavy, but as the tactical units must be preserved as complete as possible this cannot be avoided. Another important point to notice, however, is that this table is arranged upon the capabilities of the English standard gauge, whereas the South African trunk lines are considerably narrower, a circumstance which, owing to the more limited seating and loading accommodation it compels, must add to the length of the already heavy trains. Consequently, the length of the journeys to be undertaken, the narrowness of the gauge, and the economical engineering characteristics of the tracks themselves—by which we refer to the prevalence of steep gradients, to avoid the expense of cuttings, embankments, and tunnels, which will necessitate in places triple, and even quadruple locomotive power—must all tax existing resources to the utmost. These difficulties may be classified under two headings: (1) Shortage of rolling-stock; (2) necessity for a special railway corps.—*The Railway Times, India.*

FRENCH BOUNTIES AND SAILING-SHIP CONSTRUCTION.—The operation of the French bounty system on shipping, not only as regards the owning and working of ships, but also as regards building them, is proving a very magnificent affair for all concerned, and the Government chest is being drawn upon to some tune. A Clyde shipbuilder who quite recently visited St. Nazaire, Nantes, and other places on the Loire, informs us that on that river alone between twenty-five and thirty sailing ships are at present under construction. Tonnage and not constructive cost being the measure of the title to the bounties, the cheap and capacious sailing vessel is naturally being built in preference to the comparatively costly steamer. A share in the good things presently going is even being sought after and attained by enterprising builders outside of France. For some considerable time past Russell and Co., Port Glasgow, who formerly built sailing ships almost entirely, have been busily engaged in their spar-making department executing orders received from French shipbuilders for masts, spars, and other equipment destined to form part of sailing ships in course of construction in French yards, and now it is intimated that not only the masts and spars, but the actual hulls of sailing vessels, are to be prepared and shipped in pieces for reconstruction and completion on French soil. The structural material for half a dozen vessels is being prepared on the Clyde according to plans, and will be despatched to France for erection and completion. For the efficient management of a new shipbuilding establishment at Dunkirk—in which it is believed a Clyde building firm is interested, jointly with a large firm of French shipowners, who formerly had all their sailing vessels built in this country—Mr. Henry Boyd, for some years yard manager to the London and Glasgow Shipbuilding Company, Limited, has been engaged, and has just left for France. His salary will be £1000 a year and commission.

RAILWAY MATTERS.

SEVERAL railroads in the United States are using rails 45ft. and 60ft. long. They have not so far proved entirely satisfactory.

THE South-Eastern Railway Company is applying to Parliament for powers to acquire the Avenue Theatre for the extension of Charing-cross Station.

AN iradé has been issued by the Turkish Government bestowing the concession for the Anatolian railway extension from Konieh to Basra on the Deutsche Bank Syndicate.

THE Emperor of Japan has conferred the Imperial Order of the Rising Sun upon Mr. T. R. Shervinton in recognition of his services in connection with the Government Railways of Japan.

THE Board of Trade have recently confirmed Orders authorising the construction of light railways in the West Riding of the County of York in and near the Borough of Doncaster, and in the County of Caithness, between Wick and Lybster.

THE chief mechanical engineer of the London and North-Western Railway, Mr. F. W. Webb, has undertaken to defray the cost of a new addition to the Crewe Memorial Cottage Hospital. The contract for the work is £600, which Mr. Webb will pay. Mr. Webb gave £1000 towards the cost of erecting the hospital.

ON Friday last Mr. G. H. Turner, general manager of the Midland Railway, presided over a large gathering of principal officers of the company, at the Midland Hotel, at Derby, and presented valuable testimonials to Mr. H. H. Loveday, late chief inspector, who represented the Midland Company at all Government inquiries, and has just retired after forty-two years' service.

THE following figures, relating to the expansion and contraction of railway rails, 30ft. long, but of different weights, have been obtained by actual experiment in America:—Contraction caused by change of temperature from 5 deg. above zero to 20 deg. below zero, 56 lb. rail contracted $\frac{3}{16}$in., 75 lb. rail $\frac{3}{16}$in., 85 lb. rail $\frac{1}{16}$in.; expansion caused by change of temperature from 5 deg. above zero to 70 deg. above zero, 56 lb. rail $\frac{1}{3}$in., 75 lb. rail $\frac{1}{3}$in., and 85 lb. rail $\frac{1}{4}$in.

IN Canada there were 16,717 miles of railway in operation on June 30th, 1898. In addition to these, there are twenty-eight miles of railway owned by five coal and iron companies, all in Nova Scotia. Canada has 166 railways, twenty-five of which have been amalgamated, and form the Grand Trunk Railway system. The consolidation of twenty-three others has produced the Canadian Pacific Railway system. The remaining 118 have more or less consolidated.

THE Rochdale Corporation are promoting a Bill in Parliament for authority to construct a working system of tramways. The tramway will embrace a total length of about eighteen miles, and will cost, exclusive of the amount required for the purchase of the present tramway company's property, about £250,000. The scheme proposes to alter the gauge of the tramways from 3ft. 6in. to the standard gauge of 4ft. 8½in., with a view to joining up with the systems of the neighbouring authorities of Oldham and Bury.

THE construction will be soon begun of a new railway on the Island of Hawaii. It will be known as the Kohala and Hilo Railway, and will connect the port of Hilo, the principal city on the island and the east coast, with Mahukona, on the north-western coast. It will have a total mileage, including branch lines, of 130 miles, and will open to cultivation a large fertile territory originally inaccessible on account of lack of transportation facilities. The line will be operated by electricity, which will be generated by water power.

ACCORDING to the report of the *Times* correspondent at Vienna, the Russian Government is preparing to construct a railway from the South of European Russia to Turkestan, to connect the commercial centres of Russia with Central Asia by the shortest route. Two projects exist. One is for a line from Orenburg along the left bank of the Ural, through the Targai territory, *viâ* Turkestan to Tashkent. The other starts from Alexandrovsk, the terminus of the Pokrowsk-Ural line, and passes through Transcaspian territory along the left bank of the Amu Daria as far as the station of Tschardshui, on the Transcaspian Railway.

IN a paragraph inserted in this column last week we gave some figures relating to the number of locomotives in use on the London and North-Western and other railways. In this statement account was not taken of "duplicates," which, it appears, form a very important figure on some lines, but which are not shown in the stock returns of others. The London and North-Western Company show 500 duplicate engines in addition to the figure 2436 given last week, while the North-Eastern Company state their figure, 2015, includes duplicates. The Midland and Great-Western companies say nothing about duplicates, but the former company has a few, while the latter has a very large proportion, perhaps larger than any other company—probably over 30 per cent.

TWO new trains have been put in service on the Chicago and Alton Railroad, to run between Chicago and St. Louis. Each train consists of six Pullman cars, and hauled by an eight-wheel engine, built at the railway company's shops. The cars include a mail car, with anti-telescoping vestibule; a combination baggage and day car for forty passengers; a combination chair car, in which the forward half of the car is fitted with ordinary reversible seats, and the rear half with revolving chairs, for eighty passengers; another chair car—eighty passengers; a smoking and dining car; and a parlour car, having two private state rooms or compartments forward of the saloon, and a long covered and enclosed observation platform at the rear end. The mail car is 66ft. long over the sills, and 60ft. inside; the other cars are 72ft. 6in. long over the sills, and they are all mounted on six-wheel trucks.

A DEPUTATION from the Metropolitan District Association, Cyclists' Touring Club, had an interview on Tuesday with Mr. Willis, general manager of the South-Eastern and the London, Chatham, and Dover Railways, on the subject of cloak-room accommodation for cyclists at the London stations of these companies. Mr. Willis informed them that considerable improvements are about to be made at Charing-cross and Cannon-street, which will result in room being provided for at least sixty machines at each station, while at the Victoria Station sixty can be accommodated now, and assured the deputation that he would carefully consider the question of cloak-room charges for bicycles, and further mentioned that on receiving forty-eight hours' notice he would provide special accommodation and give special rates to parties of twenty or more cyclists travelling from a London station.

A DEPUTATION was some time ago sent by the Halifax Town Council to America, consisting of Mr. J. H. Whitley, vice-chairman of the Tramways Committee, and Mr. Street, electrical engineer, to inspect the tramway and electrical developments in that country, have completed their report for presentation to the Council. Regarding car equipments, they found that in hilly districts in America a new and more powerful type of motor was being used, which was less liable to failure than the small size in use in Halifax. They strongly recommended the adoption of this motor by the Town Council for all new cars for use on grades over 1 in 15. With regard to rails, 60ft. rails, the deputation found, were adopted in America in all new work. Special rails, with wider groove, and stronger and higher check, were used on all curves over 150ft. radius. These points the deputation strongly urge for imitation by the Halifax Town Council.

NOTES AND MEMORANDA.

A SCHOOL for wireless telegraphy is being established on one of the Government hulks in Portsmouth harbour, says an electrical contemporary.

ALUMINIUM has recently been used as a bearing metal for shafting in the Madras College of Engineering, and is said to have proved satisfactory.

DURING the past month five vessels of 17,370 tons in the aggregate were launched into the Wear at Sunderland, making for the present year 66 vessels of 213,251 tons. The year's total is not likely to reach that of last year, when the tonnage was 238,281.

THE Minister for Trade, Industry, Post, and Telegraph, has decided that an International Congress of methods of testing building materials should be held in Paris in 1900. The meeting will extend from the 9th to 16th July, 1900—the 14th, national holiday, being excluded.

IN connection with the use of the Marconi system of wireless telegraphy in South Africa, it is interesting to learn that cannonading does not interfere with its success. It has been tried when the biggest guns of the British Navy were firing, and not the slightest difference was perceptible.

THE coal areas of Canada are estimated at 97,200 square miles, not including areas known, but as yet undeveloped, in the Far North. There are (1) the coal fields of Nova Scotia and New Brunswick; (2) those of the North-West Territories; (3) those of the Rocky Mountains; and (4) those of British Columbia.

DURING the year 1900 the French navy will be supplemented by 32 vessels, made up as follows:—Two battleships, 1 armoured cruiser, 1 first-class cruiser, 6 destroyers, 3 gunboats, 3 submarine boats, 6 squadron torpedo boats, 9 first-class torpedo boats, and 1 turbine torpedo boat. The programme further includes 19 vessels for 1901, 13 vessels for 1902, and 3 vessels for 1903, altogether 67 vessels.

THE most recent discovery of alluvial deposits is in Tasmania. The Mount Bischoff mine, the largest lode tin mine in the world, is situated in that Colony. A more recent discovery has been the finding of huge alluvial deposits of great richness and depth. Perhaps the most famous of alluvial deposits referred to is that of the Briseis tin mine, situated at Derby, county Dorset, in the north-eastern tin field of Tasmania.

THE coal areas of Novia Scotia cover about 635 square miles, and are divided into the Cape Breton, the Picton, and the Cumberland basins. The workable thickness of the coal is very great. In Cape Breton it ranges from 25ft. to 60ft., in Picton to at least 70ft., and in Cumberland at least 30ft. The fixed carbon averages from 58 to 60 per cent., volatile combustible matter 29 to 37 per cent., water 0·75 to 1·46 per cent., and ash 3·25 to 9·34 per cent.

THE naval programme of the United States for 1900 includes three armoured cruisers of about 13 500 tons displacement each; three protected cruisers of about 8,000 tons each; six light draught gunboats of about 1000 tons each, and six smaller gunboats of about 800 tons each. This is a total of about 75,300 tons, or the largest annual increase ever proposed. At present the largest armour-clad cruiser, the Brooklyn, has a displacement of only 9215 tons.

ANOTHER seam of coal was passed through on Saturday at the boring at Ropersole, between Dover and Canterbury. The seam was 6in. thick, and of excellent quality. This makes the third thin seam passed through at this boring, which had been stopped for many weeks owing to a part of the machinery being lost in the operations. From fossiliferous evidence it is believed that the boring is passing through the upper coal measures. If so it is concluded that the carboniferous strata must continue to a very great depth in this part of Kent.

DURING the naval manœuvres which took place on the Swedish coast last summer a trial was made of Swedish coal for steam raising in the boilers of the ironclad Odin. It appears that the heating capacity was good, but the heat got rather intense in the funnel. Sufficient steam pressure was attained without difficulty, but it was found that the Swedish coal requires more firing than the Welsh coal. The capacity of the vessel was greatly reduced in using Swedish instead of Welsh coal, since it appeared that at a speed of 10 to 12 knots the consumption was 25 to 42 per cent., and at 16·7 knots up to 95 per cent. more of Swedish than Welsh coal.

H.M. CRUISER Hyacinth completed her programme of speed trials off Plymouth on Monday evening. The engines are said to have worked smoothly throughout, the power developed being considerably in excess of the amount stipulated for in the conditions of contract. The mean results were as follows:—Steam in boilers—starboard 252 lb., port 251 lb.; steam at engines—starboard 242 lb., port 240 lb.; vacuum—starboard 25in., port 26·9in.; revolutions—starboard 169·15, port 173·55; indicated horse-power—starboard 5269, port 5267, total, 10,536; speed, 19·4 knots; coal consumption per indicated horse-power per hour, 1·58 lb.; air pressure, ·25in. for last five hours.

THE manufacture of domestic utensils of aluminium is making great strides in India. The work was originally started at the School of Arts, Madras, but there are now several other centres of manufacture, and the more general adoption of the metal is being hastened by the prevailing high prices of copper and tin. A large order for cooking vessels for the 28th Madras Infantry has recently been filled at the school. These vessels have almost of necessity to be made by hand, since each native regiment has its own patterns. The production of a suitable water bottle is, however, a difficulty, as the flat pattern is not easily made in aluminium since soldering cannot be used; while a cylindrical pattern cannot be conveniently carried.

THE effects of wire drawing and annealing on the stress-strain diagram of steel wire have been studied by Mr. A. D. Keigwin, and the results given in the "Proceedings" of the Institute of Civil Engineers. The conclusions are:—(1) Steel when wire drawn has its breaking load increased. (2) When the wire is annealed the breaking load is lowered to that of the billet from which the wire was drawn; in this case an average reduction of 39 per cent. (3) The ratio of yield point to breaking load—36·7 and 31·8 per cent. for unannealed and annealed wires respectively—is lowered. (4) The ratio of the extensions at yield point and at breaking load in unannealed wire, viz., 0·25 to 0·75 per cent., is increased by annealing to 0·25 to 5 per cent. (5) The reduction of area of break is increased 16 per cent. by annealing. (6) The mean stress-strain diagram for annealed wires is a parabolic curve.

A METHOD for calculating the costs of electrical conductors made of copper, iron, or aluminium was recently given in *L'Industrie Electrique*. For a line of given length and resistance the weight of the conductor is proportional to the product of the specific resistance and the specific gravity of the material used. This product for iron is 78, for copper 14·24, and for pure aluminium 7·54. Thus we see that if aluminium costs about twice as much per pound as copper, the cost of the line will be the same for these two materials. The actual weight of a line will be $W = 0{\cdot}000205 \frac{L^2 r S}{R}$, where W = weight in pounds, L = total length of wire in feet, r = specific resistance in microhms per cubic centimetre, S = specific gravity, and R = resistance of line in ohms.

MISCELLANEA.

IN Russia reapers and binders of American design still enjoy the monopoly. Hand reapers command a ready sale, though they are gradually being superseded by self-reapers and binders.

IT is stated that a scheme is on foot to amalgamate the great chemical manufacturing business of Brunner, Mond, and Co., with that of Bowman, Thompson, Limited, of Northwich.

THE collection of photographs taken by members during the recent visit of the Institution to Switzerland will be on view in the library of the Institution of Electrical Engineers until Tuesday, the 12th inst.

THE Italian Government has approved the plan for extending the harbour of Civitavecchia. The work will cost £160,000. It is intended to deepen the harbour, construct a new breakwater, and prolong the breakwater already existing.

THE Eastern Telegraph Company has successfully completed a new cable between St. Helena and Cape Town. In a few weeks' time another section between St. Helena and St. Vincent will be laid, and the Eastern Telegraph Company will then have three alternative cable routes to South Africa.

AS a result of the dredging operations which have for some time past been in progress on the river Dnieper, steamers partially laden have recently visited Kherson. At present the depth of the fairway is only 16ft., but eventually it will be increased to 22ft., which will render Kherson accessible to British shipping.

THE questions of enlarging the existing dock accommodation at Antwerp, and also of rectifying the channel of the Scheldt by the hazardous project known as the *grande coupure*, have been settled by a compromise. Two new basins, covering fifty acres, are to be constructed outside the *enceinte* of the fortifications.

THE Urban District Council of Finedon have for some time been conducting boring operations with a view to discovering a supply of water. Success appears to have rewarded their efforts. A trial well has been sunk on the Wellingborough road to a depth of 114ft., and on Monday last contained water to a depth of 54ft.

LAST week a deputation representing 80,000 cotton operatives had an interview with Sir K. Digby at the Home-office to urge that steps should be taken for the protection of the health of the operatives by the enforcement of the order based upon the recommendations of Sir Henry Roscoe's Committee on steaming in weaving sheds.

THE steamer Kaiser Friedrich, built for, but refused by, the Norddeutscher Lloyd, having made two voyages across the Atlantic for the Hamburg-American Packet Company, will be laid up at Danzig during the winter, and will be fitted with two additional boilers. It has been found that her present boilers are unable to keep up a constant supply of steam sufficient for her powerful engines.

THE operatives in the brass trades of Birmingham, and throughout the country, have put in a demand for a fixed minimum wage of sixpence per hour and bonus, and the regulation of juvenile labour, boys only to be employed in proportion of one to four men. The employers are adverse to the proposals. Many of the operatives have expressed their intention to cease work on the 9th inst. if their terms are not conceded. Ten thousand men are involved.

THE Executive of the British Fire Prevention Committee have decided to withdraw from participating in the Paris Exhibition. This withdrawal is due to the leading members of the fire-proofing trade, who were to have been represented by a large collective exhibit, arranged under the auspices of the Committee, considering that the general tenour of French political, business, and social feeling towards Englishmen has of late been anything but satisfactory.

THE Hamburg-American Line and North German Lloyds are each having their two new mail vessels fitted with ice-making and refrigerating machinery on the Linde system. In addition to the usual cold chambers and ice-making plant, two of the state rooms have been cooled. This is said to be the first instance of state rooms being cooled by means of refrigerating machinery, though in several cases such machinery is used for cooling dwelling-houses on land.

WITH the object of preventing the escape of water from the Manchester Ship Canal into the estuary of the Mersey, at the site of the tidal opening at Ellesmere Port, the Canal Company propose to construct an earthern embankment, 250 yards in length, which will exclude about 11,500 cubic feet of tidal water on a 21ft. tide. The embankment will be 23 yards wide at the base, and of an average height of 6ft. The work will be proceeded with immediately upon the necessary authority being granted.

THE new Kaiser dry dock at Bremerhaven is the first German dry dock built entirely of stone, and is not only the largest dry dock in Germany, but one of the largest in the world. It is 722ft. in length, 90½ft. in breadth, and 31ft. deep. The closing of this dock is accomplished by means of a lifting pontoon, which can be removed from the outer end of the dock to a point some distance inside, when it is desired to dock a small vessel. The dock can be emptied in from 2 to 2½ hours. On either side of the dock are two cranes of 50 tons capacity, and at the south-east corner is a crane with a lifting capacity of 150 tons.

AT the Derby County Police-court last week, T. C. Aveling and Co., of Birmingham, were summoned for failing to affix a registration plate to a locomotive of which they were the owners, and also for not affixing two lights to the engine. The driver was summoned for driving the locomotive engine over a bridge at Egginton which was notified as dangerous. It was stated that the bridge in question was about 700 years old. For not having lights attached defendants were fined £1 and costs, the charge of not having a name-plate on the locomotive being withdrawn. For driving the locomotive over the bridge a fine of 20s. and costs was imposed.

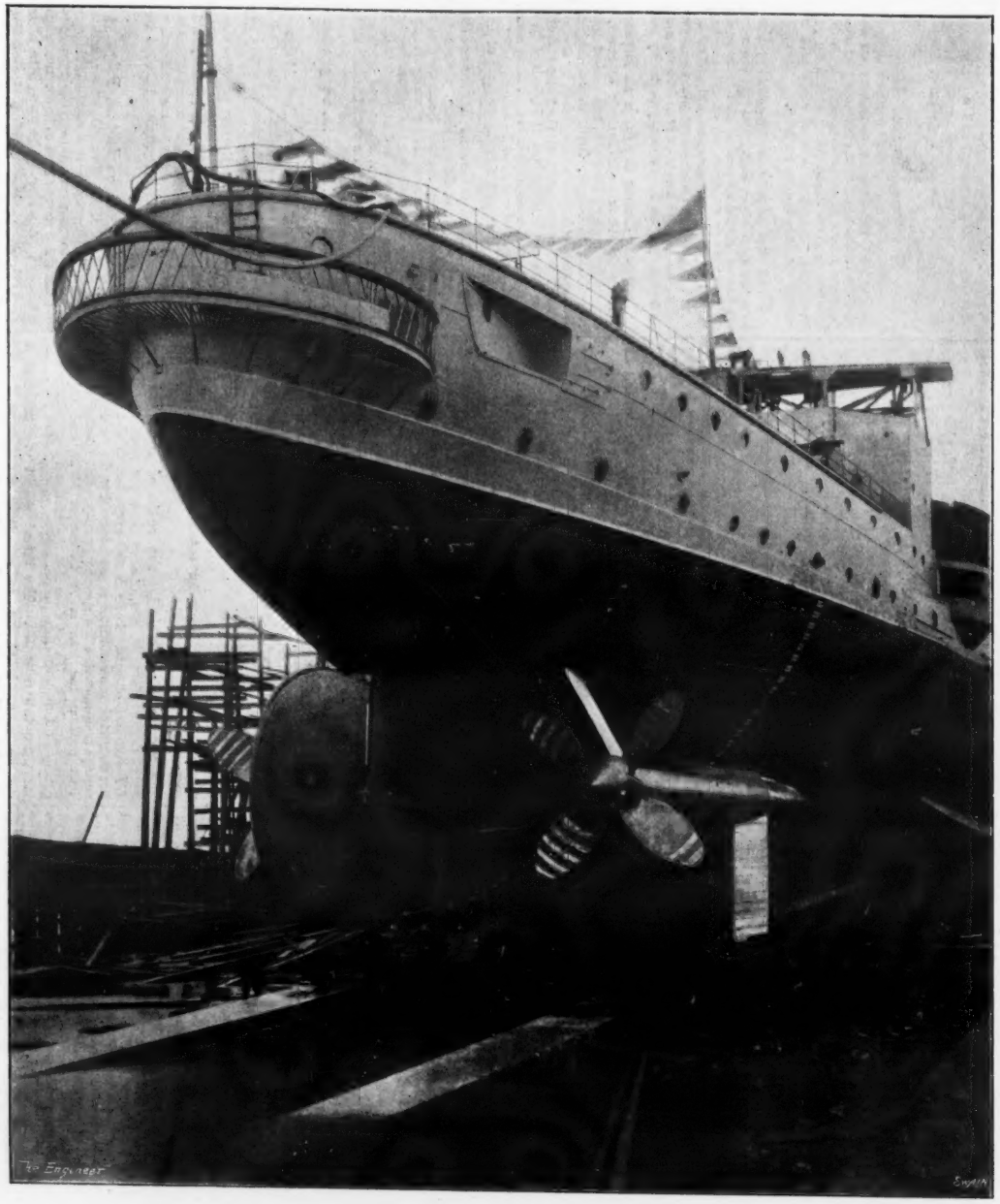
RUSSIA'S occupation of Port Arthur and Talienwan has already produced an effect on Russian trade with the Far East, and it is believed that the enforcement of the decree of May 27th, 1897, which will come into force in January, restricting the carrying trade between all Russian ports to vessels under the Russian flag, will give a great additional impetus to this exchange of commodities between European Russia and Eastern Siberia. The increase of shipping brought about in this manner will necessitate the purchase of new steamers from abroad, which is now feasible, as steamers for Russia constructed abroad are no longer subjected to customs duties.

A PROPOSAL is on foot at Paignton to derive a supply of water from Holne Moor, Dartmoor, and to purchase 700 acres of land having upon it a considerable stream of water. It is proposed to construct a reservoir capable of holding 180,000,000 gallons. A dam will have to be constructed 50ft. high and between 400ft. and 500ft. long. The water is to be conveyed to Paignton by a 9in. main. At Marldon, near Paignton, a smaller reservoir is proposed for the supply of the higher levels. There also will be small filter beds. The cost of the land at Holne and Marldon is estimated at £8000, and the remainder of the scheme, reservoirs, pipes, &c., is put down at £38,198, making together £46,198 10s. for the entire scheme.

H M. S. CRESSY

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, BUILDERS AND ENGINEERS

(*For description see page 564*



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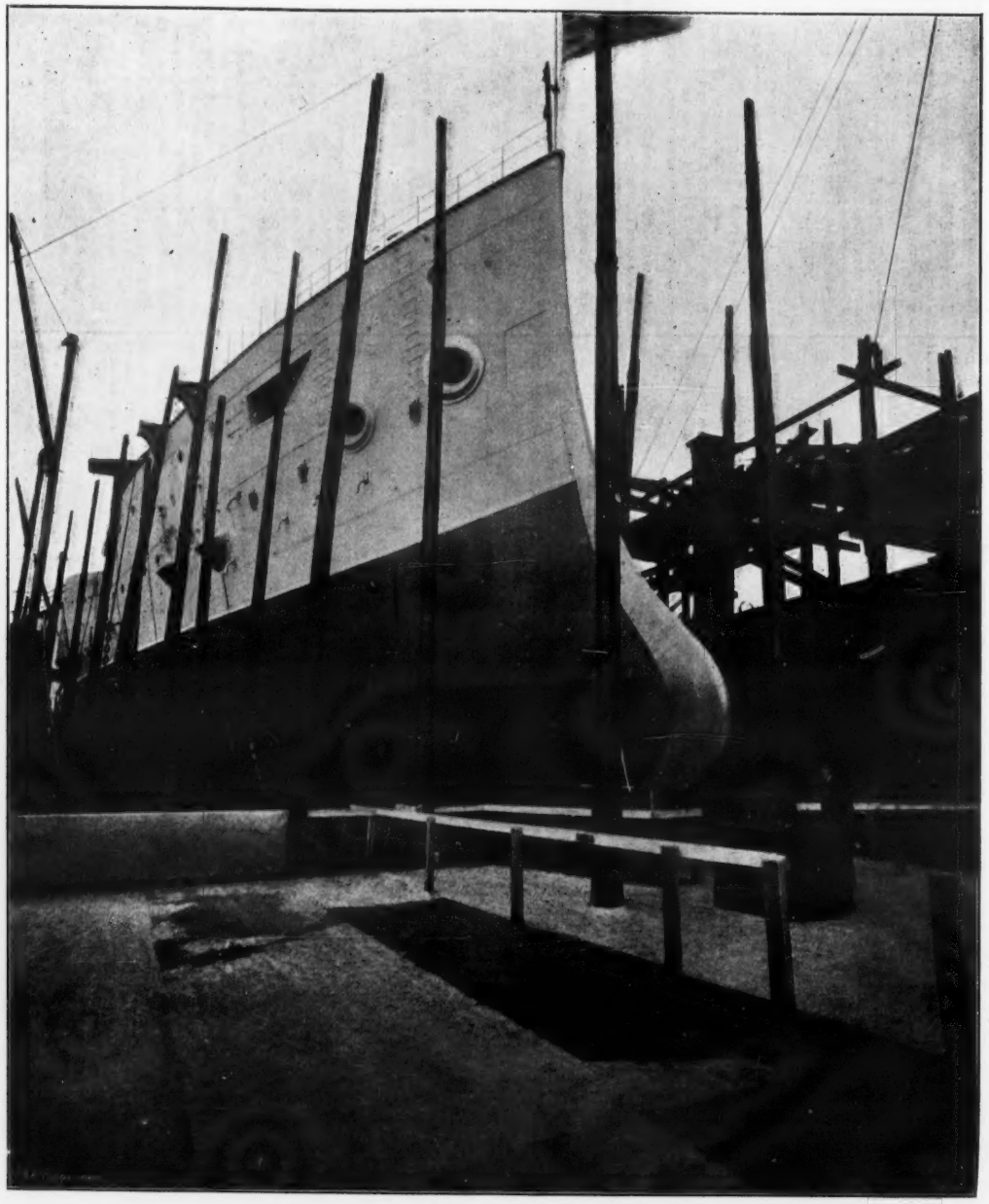

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

PUBLISHER'S NOTICE.

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

W. H. S. (Northfleet).—Write to Mr. Ingham, borough water engineer, Torquay.

G. F. T.—You will find detailed drawings and a specification of the Metropolitan Western Pumping Station at Pimlico in THE ENGINEER for August 15th and 29th, 1873.

E. K. (Goole).—(1) Yes. The gentleman you name is alive. (2) You can obtain full particulars by addressing an inquiry to the Marine Department of the Board of Trade, Whitehall.

J. S (London).—We think that if you apply to Mr. Charles Wood, of the Cleveland Institution of Engineers, Middlesbrough, or to C. Isler and Co., of Bear-lane, Southwark, S.E., you may obtain the information you require.

F. M. P. (Texas).—We presume you refer to the Rob Roy type of canoe. There are several books published which give full instructions for making them. See Nelson and Kemp's "Practical Boat-building," Part I., published by L. Upcott Gill, 170, Strand, London.

J. B.—You might read Mr. Manuel's paper, read before the Institution of Naval Architects in 1897. A copy might be obtained from the Secretary at the home of the Institution, Adelphi-terrace. You might also write to the Secretary of the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne.

INQUIRIES.

BRAENDER'S JET PUMP.

SIR,—Can any of your readers give us any information about Braender's jet pump?

London, November 30th. M. AND V.

ORE SEPARATOR.

SIR,—I shall be greatly obliged if any of your readers can give me the address of the makers of a machine for separating minerals from ores by centrifugal force, patented by Stanfield and Clarkson, No. 810 of 1889.

Southampton, December 5th. F. J. C.

MEETINGS NEXT WEEK.

LIVERPOOL ENGINEERING SOCIETY.—Wednesday, December 13th, at 8 p.m. Paper, "Heavy Motor Lorries for Liverpool Traffic," by Mr. Arthur Musker, Assoc. M. Inst. C.E., M.I. Mech. E.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Monday, December 11th, at 7.30 p.m., at the Institution, Storey's gate, Westminster, Graduates' Meeting. Paper, "Works Management, Methods of Quick Production of Repetition Work," by Mr. W. B. Cleverly.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 12th, at 8 p.m., Ordinary Meeting. Paper to be discussed, "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc. M. Inst. C.E.—Friday, December 15th, at 8 p.m., Students' Meeting. Paper, "On Sludge," by Mr. Blamey Stevens, Stud. Inst. C.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Wednesday, December 13th, at 7.30 p.m., in the Library of the Institution, 28, Victoria street, Students' Meeting. Paper, "Electric Tramways," by Mr. R. Grigg, Student.—Thursday, December 14th, at 8 p.m., at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. Paper, "Electrical Time Service," by Mr. F. Hope-Jones.

SOCIETY OF ARTS.—Monday, December 11th, at 8 p.m. Cantor Lectures. Four Lectures on "Enamelling upon Metals," by Mr. Henry Hardinge Cunynghame. Lecture IV.: The application of enamel to jewellery—Gold working—Gilding.—Wednesday, December 13th, at 8 p.m., Ordinary Meeting. Paper, "Sea Angling and Legislation," by Mr. F. G. Aflalo.—Thursday, December 14th, at 4.30 p.m. Indian Section. Paper, "Round about the Andamans and Nicobars," by Col. R. C. Temple, C.I.E.

THE ENGINEER.

DECEMBER 8, 1899.

ELECTRIC LIGHTING COMPANIES AND CONSUMERS.

WE understand that the London customers of two great electric lighting companies are memorialising the Board of Trade on the shortcomings of the companies, who, it is alleged, are not fulfilling the conditions of their undertakings. What the consumers hope to gain by their memorial it is not easy to see. The Board of Trade cannot supply the deficiencies of the companies; and these latter require no stimulus to urge them to fulfil their agreements. It is indisputable, however, that consumers in various districts of the metropolis have grave reason to complain. When a West-end householder is told that he can have no light between five and seven or eight o'clock p.m. for weeks together; and when promises of amendment are made only to be broken, it is not remarkable that the sufferer should take any action he can which promises either redress of his wrongs or the punishment of the criminal. The matter has reached such a stage now that it ought to be fully discussed, and the facts made as public as possible, and to this end we endeavour to put them briefly before our readers.

It is an open secret that almost from the first day that electric lighting has been attempted in London, difficulties and troubles of various kinds beset the companies who undertook to supply current. We do not refer now to legal difficulties and hindrances such as injunctions for nuisance. The troubles to which we refer have all been strictly technical. They have had to do with boilers, water, engines, dynamos, transformers, cables, meters, lamps. A book, and that a large one, would be needed to record the scientific history of the introduction of the electric light. No volume could be more instructive; none is less likely to be written, for each company has had its special troubles, and each has, as far as possible, kept their precise nature and magnitude secret. The general cause of all this worry and perplexity is very obvious. Electric lighting on a great scale was a new thing, and no one knew much about it. It would be unwise to say at this moment that our knowledge is now complete, and yet the first satisfactory incandescent lighting done in this country dates back to about the year 1881. For more than eighteen years professors, inventors, electricians, and engineers have been struggling with the subject, and still much of the utmost importance remains to be learned, and electric lighting practice is as yet unsettled, vague, and indeterminate. Every generating station in the kingdom has been an experiment; and there is no station of importance even now in which what it is hoped will be improvements are not being introduced, each one of which is, in essence, an experiment. Furthermore, it must not be forgotten that those who undertook electric lighting were for the most part enthusiasts; and not content with the idea that the electric light should in itself represent the furthest advance of science, they determined that the machinery employed for its production should also represent the van of steam engineering. It is matter of comfort that one or two engineering firms stood steadfast, and insisted that the first essential was an engine that would not break down, and that the adoption of exceptional devices intended to secure great economy should be postponed until plenty of experience had been acquired. The wisdom of the policy was proved when the slow-speed engines of one eminent firm had at exhibitions to take over time after time the load that high-speed or complicated engines were unable to carry. The main result has been that electric lighting stations, which must in any case be tentative, became much more the scenes of experiment than was either essential or prudent. Meanwhile enough was done to make the public anxious to get the electric light; directors managers, secretaries of companies, keenly competitive, fought for custom, and got it. In a very short time overloading at central stations became the rule instead of the exception. Then it began to be realised that there was a terrible peak in the diagram of output every night, which meant a very bad three-quarters of an hour, and seemed to defy all previous calculations. But apart from this, the work of wiring and taking on districts extended far more rapidly than the development of power. Serious evils ensued. No time was available for effecting proper repairs or cleaning boilers. A three-days' fog meant destruction. Only those who have been behind the scenes can realise what has gone on night after night in various stations. The mysterious breakdowns; the coming of disaster like a bolt from the sky; a dynamo which has run perfectly for months practically disappearing in a torrent of blue fire; a cylinder splitting; a cable going for no ostensible reason; a set of transformers ruined in a moment. The outsider, wise after the event, says the causes ought to have been foreseen; and this to men of the highest available talent, and possessing the maximum of experience. The electric lighting companies in and round London have for years past been working under difficulties. Their machinery has been taxed to the utmost limit of endurance on occasions. They have had, over and over again, to help one another in moments of sore trial. Two or three years ago one of our electrical contemporaries in an excess of unusual candour, published a clever cartoon, in which the various companies were represented by so many steamships tossing in a fearful sea; some nearly foundering, others trying by towing to lend them aid. The cartoon was elicited by a tremendous and long-continued fog, which had wrapped London in a pall for nearly a week. There have been minor troubles, but the great trouble which has mainly concerned the public may be stated in two words—over load.

The consumer will very naturally say, "This is all very well, but who is to blame? Why is it that I, who have contracted for the steady supply of light, cannot get it? An east-end water company can plead as its defence that the heavens warred against it, and no rain fell. But the electric lighting companies have no clerk of the weather to fall back on." The question is very easily answered. The companies have not been managed by business men on business principles, and they have undertaken work before they were in a position to do it. The engineers are not to blame; the electricians are not in fault. The secretaries and managers have been, in the past at all events. As to the present distress they have some excuse. They can plead the legacy left by the great strike of the Amalgamated Engineers, and the overwhelming rush for machinery of all kinds that has rendered the fast passing year memorable. The full effect of the difficulty of obtaining material and machinery it is not easy for the general public to understand. We may cite two or three examples which may be useful. It has been impossible until quite recently to place orders anywhere for the prompt delivery of Portland cement, of which hundreds of tons are used for foundations. Bricks went to an enormous price; bricklayers have been earning in London 1s. 1d. per hour. Girders for floors have been unattainable. Such difficulties as these have retarded the construction of buildings into which to put new plant. Boilers which have already been overloaded, are now more overloaded than ever, because additional boilers have been delivered four or five months late. When great batteries of boilers are so worked that none of them can be spared for thorough cleaning and repair, disaster is certain to follow. The defence of the boiler maker is that he could not get delivery of plates. The argument that he was wrong to promise what he could not perform has little force of condemnation. The rush of trade has taken every one by surprise in this country, just as it has taken every one by surprise in the United States. It is useless to talk of putting down new dynamos at once, when you are told by some makers that they will not take your order at all, and by others that from six to eight months is the earliest time of delivery. How vain it is to think of getting new engines in a hurry is set forth by the history of the Glasgow Corporation.

With all this admitted, however, we think that there is little excuse to be pleaded for those who, having supplied a district regularly and satisfactorily for months or years, cease to do so, not because their plant is not still competent to do it, but because the company has undertaken additional districts, demanding additional plant to supply them, and not having this plant, has thrown the extra work on machinery already loaded within an inch of its

life. Then when the peak comes which the engines cannot possibly carry, the company takes current from the old customers to satisfy the demands of the new. What excuse can be alleged for this we fail to see. Meanwhile we are unable to suggest a way out of the difficulty, all that can be done no doubt will be done, but customers who now leave one company and take current from a rival will do well to exercise caution. There is not a pin to choose between any of them as regards promises, and it is just as likely as not that those who throw over company A in disgust will find that company B is just doing that for which A has been left, namely, in the keen pursuit of custom, taking on more work than it can perform. As we have said, we repeat, that haste and want of discretion in extending business, lies at the foundation of most of the troubles to which the consumer is now subjected. The evils have been greatly accentuated in the way we have explained. Unfortunately, the only thing that we can suggest is patience. Things will come right in a short time, and those who have left companies which have treated them well in the past in favour of others may have reason to regret the change. It would be difficult to name any company which is at this moment in a position to add to its load with safety.

The legal remedies likely to meet the case in the future would probably take such a form that no company could undertake to light a district until a certificate had been obtained from the Board of Trade that the plant was in all respects sufficient and efficient, very much in the same way that a Board of Trade certificate must be obtained before a railway company can open a line. Against this it may be urged that the repeal of an existing clause in the Companies Acts, by which they are compelled to supply current to anyone asking for it in a district where the mains are available, would be necessary. Furthermore, no matter how efficient plant might be to begin with, deterioration takes place; and to throw on the Board of Trade the responsibility of seeing that the plant was always kept up to a proper standard of efficiency would be extremely unwise. As we have said, so we repeat, that a little patience on the part of consumers will probably have its full reward. It should not be forgotten that parliamentary interference in the past, by stifling enterprise, is largely responsible for the troubles now experienced.

BOILER EXPLOSIONS AND INSPECTION.

ON the 1st of November a boiler explosion occurred at the cutlery works of Messrs. Southern and Richardson, Sheffield, resulting in the death of seven persons. The coroner's inquest was concluded on Friday last. The Board of Trade inquiry has only just been held. The accident was ascribed to low water, due to a faulty gauge glass. The boiler was of the Lancashire type. It was purchased in 1875 from Hawkesley, Wild, and Co., and had been insured in the Engine, Boiler, and Employers' Liability Insurance Corporation, Limited, since 1885. From that time it had been inspected internally once a year except on one occasion, the last inspection taking place about twelve months ago. At the time of this inspection the boiler had not been scaled, and the examination was not satisfactory, but the insurance company does not appear to have requested permission to make a second internal inspection. The boiler was cleaned four times a year, the last time being in August. Two gauge glasses were fitted to the boiler, but ten days previously to the explosion one had been put out of work. The other was in use, and apparently indicated that there was sufficient water in the boiler. But on careful inspection, after the accident, it was found that the top passage was entirely choked by incrustation, and the gauge had thus given a false indication. Mr. Edward Hiller, chief engineer and manager of the National Boiler and General Insurance Company, Manchester, gave it as his opinion that low water, resulting from the defective gauge, was the sole cause of the explosion, and that the boiler was in a sound condition.

In the course of his address to the jury, the coroner made the following remark, and it is with the object of commenting on this passage that we have given the above particulars. We quote from a local paper:—"He thought there should be some compulsory examination of boilers. If owners did not insure their boilers they might go on without any inspection whatever. He was told by Commander Hamilton Smith, who had given him great assistance on that inquest, that there might be shortly some legislation on this matter. There should be some efficient examination by compulsion or otherwise, and they could rest assured that any increased or better inspection would tend to a decrease of such accidents in the future as that which they had that day inquired into." The question of the Government inspection of steam boilers is by no means new. The coroner in the present instance is not the only one who has commented on the necessity for compulsory inspection of boilers. But in common with other persons he has evidently not directed serious attention to the subject. Legislation of this description is surrounded by difficulties. The fact that no satisfactory scheme has yet been brought forward, although many have been discussed, is sufficient to prove the truth of this statement. There is one fundamental objection which, from the nature of the case, it appears cannot be surmounted. It is the shifting of the responsibility of the person who uses the boiler on to the shoulders of the inspector. It must be remembered that a very large number of boilers are owned and tended by men without any technical training. Not many months ago we saw a boiler which was used for driving a farm engine. It was of the Cornish type, and must have been of considerable age. The flue was composed of plates some 2ft. 6in. to 3ft. square, riveted together. The boiler was, perhaps, 14ft. in length. The fireman and engine-driver was a farm hand, the owner a farmer. Neither one nor the other had the slightest knowledge of engineering. The pressure at which the boiler was worked was, if we remember right, 25 lb. to 30 lb. We have no hesitation in saying that it was in an absolutely dangerous condition. The flue at some time had been overheated, and was seriously distorted. There was no safety plug in it. The age of the boiler, as we have said, was considerable, and there can be little question that the flue-plates were reduced at places to less than half the original thickness. There were clear indications of weakness at the corners of the riveted seams, where the plates had been hammered out for jointing. There was, of course, only one steam gauge—until a few months previously there had been only one water gauge. A water level float was fitted. The safety valve was entirely open and exposed; it was of the simple lever and weight class. The outside of the boiler being bricked round, we had no opportunity of examining it; but we have said enough to show that the boiler was worked on the edge of a disaster. It had been purchased second-hand some years previously. It had never been inspected by an expert, and was not insured. The farmer had no conception of the risk he was running in using it. Such a case may be taken as typical of many others. Let us consider the possibilities of dealing with these two cases by legislation. Suppose that inspection is enforced by Act of Parliament. The examiner overhauls the boiler, he has this thing and that done. He passes one as good for 60 lb. pressure, the other he reduces to 15. He tests the pressure gauge and the gauge glass and sees that the safety valve is in working order; he gives a written guarantee that the boiler has been passed by him, and goes away for three months or more. What happens? The owners feel themselves free of all responsibility. The farmer puts his hind on to stoke and feed, and troubles himself no more. A gauge glass gets broken, and weeks are allowed to elapse before it is repaired; the other is carelessly used or is not kept clean. Water gets low, the crown gets hot, and an explosion occurs. An inquest and formal inquiry are held. The farmer was working his boiler in the way he had been instructed by the inspector. He claims that he has no responsibility in the matter, that he is ignorant of boiler management, and that he is not conscious of negligence, because he did not know what else he could do. There is nothing fanciful in this case. It has happened over and over again, with and without inspection; the owner has paid the cost of the inquiry, put in another boiler, and gone on again in a greater false sense of security than before. It is true that the inspector might refuse altogether to pass a boiler so bad as that we saw. But would matters be improved? A new boiler in incompetent hands is very little, if any, less dangerous than an old one. The boiler at Sheffield was shown to be in good condition. Inspection is almost useless in such cases. It could only be really effective if the inspector was constantly on duty, travelling from place to place, and arriving at all times and all hours. The difficulties of such a system are fairly obvious.

There are, however, two directions in which it is argued that possible legislation might be effective. In the first place, the employment of certified engine drivers and stokers might be made compulsory; and in the second, regulations with regard to boiler fittings might be enforced. There are grave objections to the first scheme so often discussed that we need not further refer to them now. As to the second, it might be held imperative to fit two pressure gauges on entirely independent positions, and to have them checked at least once a year. An enclosed type of safety valve might be employed, and the use of a safety plug in the furnace made compulsory. The double gauge glass on one column should not be generally permitted, because any stoppage in the main passages affects both glasses. Other regulations might be found necessary. By taking certain precautions the weakest boiler can be rendered safe for some pressures, and if the neglect of such precautions should be considered criminal negligence and severely punishable, even though no accident had taken place, it is possible that boiler explosions would be fewer than they are.

We say it is possible, but we confess to being in no little doubt about the probability. It is true that investigation nearly always shows that boiler explosions can be attributed to well understood causes, but in many cases the remarkable coincidence of events which lead to a disaster elude the power of man to foresee or to obviate. And again, although it would appear a natural conclusion that a boiler would be safer in the hands of an expert than in those of an ignoramus, it has to be admitted that accidents under the latter circumstances are rare, and that they do occur, as for example at sea, in the hands of men of the highest training. It is one of those unfortunate cases in which statistics refuse to assist the argument which is obviously correct. On the whole, if legislation is to take place, the following points appear to us to be worthy of attention. Let there be a compulsory annual inspection by some recognised authority, insist on all fittings being in duplicate and independent; do not permit the use of water which exceeds certain specified limits of hardness; see that every boiler attendant is competent, and allow no boiler to be offered for sale, either new or second hand, without a guarantee that it is suitable to be used under the specified conditions.

PROJECTILES AND THEIR EFFECTS IN SOUTH AFRICA.

THE action of various projectiles in war has not unnaturally attracted considerable attention, and a few words on certain points may be acceptable. Our field artillery carry in their ordinary equipment shrapnel, but no common shell. Shrapnel are the most efficient projectiles for the attack of troops in the field. They should be opened with a time fuze in the air, in front of the troops attacked. If a compact body, the best effect would be produced by the shell opening fairly close to them; if in extended formation, the shell acts best if burst sooner, so as to enable the bullets to spread. The shell is opened with a small bursting charge, and the bullets being released go on in a shower, spreading wider as they go further, and considerable skill is required to obtain good results. If the distance is misjudged or the fuze set wrongly, the effect may be almost nothing, and the appearance of the burst from the firing point is apt to be misleading. When well delivered the effect is very great on open ground, especially if the surface is hard and flat. Against men behind breastworks or fair cover of any kind, shrapnel generally fail, because the bullets all going onwards will not injure men with protection in front of them. Under ordinary conditions, in good hands shrapnel is the best projectile for a field gun of small calibre, say, 3in.

To search behind cover or attack defences and strike men protected in front, howitzers of large bore up to 6in. are used. They fire common shell, which, unlike shrapnel, are opened with violence by large bursting charges. Such shell breach and blow about parapets and buildings, and the fragments of shell fly in all directions, so that men are liable to be struck by fragments coming back from shells that have burst beyond them, especially as these shells are discharged with a low velocity and higher elevation than projectiles from ordinary field guns. Unquestionably our artillery would have produced more effect in the attack of any of the strong positions held by Boers had they had howitzers and common shells, instead of field guns with shrapnel; but only the larger howitzers would command long ranges.

This brings us to the question of the bursting charge. We use Lyddite, and objection has been made to it by critics. It is well to say then that Lyddite is very nearly, if not absolutely, the same thing as melinite. Those interested in the latter compound consider that our Government behaved meanly and unfairly in refusing to give money to M. Turpin for his invention. They represent that the plea made by us was that whereas melinite consists of picric acid run in liquid, Lyddite consists of picric acid stemmed or pressed in dry, and that in a short time we took to running in our picric acid melted, so that it then became melinite. We have no desire to enter into this controversy, especially as we do not know the reply that would be made on the behalf of our authorities. Our object in mentioning it is to show that no declaration could be made that Lyddite was not to be used in war that would not condemn melinite, both being practically picric acid. For the information of any of our readers who are unacquainted with this substance, we may observe that it is generally met with in the form of grains of a bright sulphur yellow colour having a very bitter taste. The effect in action of melinite or Lyddite is to shiver a shell or any surrounding substance violently with a very sharp report into much smaller fragments than will powder, and to project it so violently that at very short range, say 500 yards, pieces would come back to the battery.

Lastly, to come to small-arm bullets. We have before noticed these, but a few words may be desirable, because the *Lancet* has just given the result of a practical comparison of effects produced by the very bullets employed by the Boers and ourselves, as well as some which might be employed but are condemned as inhuman. The destructive effects obtained by Dr. Arthur Keith and Mr. Hugh Rigby were relatively as follows:—The Mauser bullet 1; the British Mark II. bullet, with nickel cover and solid head, 1·7; the Mark IV., with hollow in head, 2; and the Dum-Dum, with nickel removed from bullet point, 5·4. This bears out the statement that we have repeatedly made that the Dum-Dum is a cruel bullet and not to be defended, though the experimenters say that by no means could they produce the effects attributed to the Dum-Dum by Herr von Bruns.

We have, as we have stated, issued Mark III. bullet with solid head to the troops going to the Cape. Supposing we use this and the Boers keep to their Mauser in its natural condition, our bullet on impact injures more than theirs. Both, however, injure very little. On the other hand, the Martini, which they possessed also, would produce very much greater injury, though we cannot say how much. Shooting qualities, however, may determine the use of one bullet rather than another at the expense of some effect on impact; indeed, this applies to the introduction of the 0·3in. bores of all kinds. The Boers also have found their Martinis unreliable, and probably are using but few of them. This brings us to a difficulty which we think may become acute shortly. The Boers are said to have used Dum-Dum bullets. The fact is that this bullet is the result of an impromptu effort to give bullets which had proved nearly useless, some stopping power, by removing the nickel from the bullet point with a knife. This was afterwards an article manufactured at Dum-Dum, though we have never made it in England. The Boers are accused of using such bullets now, and we think that the temptation to do so is so great that it may be difficult to prevent it. The Mark III. bullet may go through a man without his being sure that he is hit, as in the case of Lord Masham's miner. If the Mauser bullet is much less effectual, it is expecting more from the Boer than we are likely to get, if he is asked to withhold the knife from his ammunition. But if this is to be, we ought to give our men something more effectual than Mark III. Can we fairly expect an infantry man to use a bullet with no stopping power against a charging enemy? The charging enemy hitherto has been the British soldier, so that the Boer, to do him justice, is the sorely tempted man. We shall be surprised if he does not succumb to the temptation, and our authorities will have to face the question what to do next. The slight wound produced by small-bore nickel sheathed bullets should be borne in mind in estimating the numbers of wounded. For example, after any battle, such as Modder River, if we find that only a small proportion of our wounded are unable to move easily, we may conclude that the wounded Boers captured bear somewhat the same proportion to their wounded who have escaped.

THE PACT OF PEACE IN SOUTH WALES.

THE beginning of December finds the South Wales industries—its railways, collieries, steel works, and all concerned in them—in full enjoyment of a double boon

The settlement of the outstanding labour disputes, except for an immaterial relic of the Swansea district disturbance, ensures the coalfields a period of domestic peace. The high prices and demand for steam coal have not abated, and the men who predicted that the quotation would be a guinea per ton before Christmas may fairly say, with Lord Clive, that they are "astonished at their own moderation." Our trade report last week mentioned that some urgent parcels were shipped at 25s. per ton, and our correspondent describes how the rise in the rates for "Cardiff" coal has operated to the benefit of the only little less valuable "Newport" commodity, and caused an increase in the price of all other classes of fuel. From the same source comes a similarly satisfactory account of the product and the prices at the iron and steel works; and the remarkable advance in market quotations of the erstwhile discarded Ebbw Vale securities is a valid sign that investors who may be presumed to have an inner knowledge are renewing their confidence in the future prosperity of the pig iron and steel manufacture on that side of the country. But to a whole host of people, scattered all over the kingdom, one of the most welcome indications of continued peace and prosperity in South Wales will be found in the fact that the truce established last year between the Glamorganshire railway and dock companies is still observed, and will be maintained at any rate until the session of 1901. The final day for the publication of Parliamentary Notices was last Monday, and those forecasts of the Private Bill legislation, from a once extraordinarily combative region, are as encouraging as every other circumstance of the outlook. There is no word, it is true, of amalgamation, or of the progress of the negotiations towards a working agreement, with its consequent economy of management, its equitable distribution of traffic, its safeguards against an eager competition which has led to the reckless cuttings of rates, and even now permits a system of rebates and allowances which are only a disguised form of underselling. There is no confirmation, either, of the reported alliance between the Cardiff Railway Company and the Taff Vale, by which the latter was to be allowed to build its Windsor Dock, in return for the grant of running powers over its lines to the Cardiff Railway (otherwise the Bute Dock Company) northwards up the valleys of Merthyr and Aberdare. The negative evidence, in this connection, is far more important than the positive facts the chief protagonists of former times deal with in their statutory notices of action. Briefly, the Taff Vale Railway seeks to make two or three short branch lines, and assume the charges of the Windsor Dock promotion in previous sessions. The Barry Railway renews its request for power to construct or subsidise passenger steamships, to ply, of course, from its docks. The Cardiff Railway has no Bill of its own, so that it has manifestly relinquished, for the present, at least, the idea of converting the Glamorganshire Canal into railways to Merthyr and Aberdare. The only belligerent is the Rhymney Railway, which after years of patient endurance under attack, now takes the field with a proposal to counteract the Barry Railway's advance into Monmouthshire, by extending its own lines to the new collieries springing up on the eastward, and making a junction with the sidings of the Tredegar Iron and Coal Company still further on the eastward side. There will not be a quadrangular fight; not even a triangular duel. The Rhymney Railway's struggle for self-protection is to be the main combat of South Wales next spring.

THE INSTITUTION OF CIVIL ENGINEERS.

THE meeting of the Institution of Civil Engineers on Tuesday evening last was remarkable for more reasons than one. The first of these was the number of members and associate members elected. The ballot sheet contained the names of thirteen members, and no less than ninety-six associate members. We cannot call to mind any occasion on which so many have been elected at a single meeting. A further noteworthy circumstance was the fact that the discussion on the two Waterloo and City papers was continued right through the evening—the third complete evening's discussion—and would, without any doubt whatever, have gone on still longer had not the President applied the closure. He did this twice—once to the discussion proper, though there were others to speak, and, lastly, to the reply of one of the authors. This almost appeared inopportune, in spite of the fact that 9.30 had been reached. The discussion was again full of interest Mr. Alexander Siemens defended British practice against all comers—even American—and gave it out that to recommend, one system—such as the three-phase—for all kinds of work was bad, and was a sign of weakness. This is eminently true, and in no instance more so than in electrical appliances. The controller of the train motors came in for a considerable amount of adverse criticism, one speaker going so far as to designate it as being the size of a small house. In fact, to hear some of the things said about this railway and its equipment, one almost wonders that the trains run at all—but they do for all that. Sir Alexander Binnie is a regular attendant at the Council table. He was there on Tuesday night, and was called upon to speak. His voice sounded as though he wished he had not, for it had a distinctly sad ring in it. He made an apt simile, however, which brought a smile to all faces. The question was: "Why, when you have got at least a hundred feet of London clay, should you tunnel above it?" "Downward there is no limit," said Sir Alexander—even in the eye of the law; and the engineers who would not go deep enough reminded him of bathers who, having taken off their clothes, yet hesitate to take the plunge. Why not go lower—out of the way of water-bearing strata, and use lifts at the stations? Sir Douglas Fox heartily endorsed this. As to the remainder of the discussion, there was not much in it. One member shot figures at the meeting in a quite bewildering way, but they were quite harmless. There was a warm ten minutes, though, when Mr. Dalrymple Hay was replying. He did not appreciate the criticisms which had been passed on his paper. He ridiculed the fact that the London clay could "creep" at an appreciable rate, and told how a certain portion had only moved $\frac{1}{27}$th of an inch in an hour. "Perhaps," he added, "we did not arrive at the right time." He was quite thrilling as to the difficulties to be met with in tunnelling, and one can quite understand that things may be a bit lively when "the District Railway is dancing about on the top!" Mr. Newton Russell has been waiting patiently through several meetings to read his paper on "Refuse Destructors and Power Plants," and even now has to wait till next Tuesday.

CLYDE SHIPBUILDING.

CLYDE shipbuilders during the month of November sent off the stocks 38,830 tons gross of new shipping, as compared with 33,350 tons the month previous, and 31,000 tons for November of last year. The present November output, in fact, has only been twice exceeded in any corresponding period during the past ten years. The aggregate output for the eleven months now past reaches 406,770 tons, which is much the highest figure for any corresponding period in the previous history of the industry. The aggregate for the whole twelve months is almost certain to be the record output, it being only necessary that the output for December should reach 60,000 tons in order to equal last year's grand aggregate, which was 466,800 tons, and the highest figure ever reached. December outputs as a rule exceed those of the other months, and there is every probability that it will on this occasion reach not only 60,000 tons, but 70,000 tons or more, seeing that two vessels, each of over 10,000 tons, and a warship of 12,000 tons, fall to be sent off the stocks before the end of the year. The new work placed with the Clyde builders during November amounts altogether to about 40,000 tons. While inquirers have been numerous, only those owners urgently requiring fresh tonnage have closed contracts in face of the almost prohibitive prices asked by builders. A contract of some importance and of peculiar character is that entered into by Russell and Co., Port Glasgow, with French owners and builders, whereby they will construct six sailing vessels in such a way that the parts may be shipped and put together in shipyards in France. Of the more important vessels contracted for, two were large cargo steamers of between 5000 and 6000 tons deadweight, to be built by C. Connell and Co. for James Gardiner and Co., Glasgow; a steamer of about 5000 tons by the London and Glasgow Shipbuilding Company for McGregor, Gow, and Co., London; a cross-Channel steamer by the Ailsa Shipbuilding Company for the Laird Line; a high-speed paddle steamer by S. McKnight and Co., Ayr, for South of England owners. East Coast of Scotland builders during November booked several important orders, amongst these being two steamers by Gourlay Bros. and Co., Dundee, one for the Great Eastern Railway Company's service from Harwich, and another for English owners; a steamer of 225ft. length by the Caledon Shipbuilding and Engineering Company, for service on the Canadian Lakes; a screw steamer of 2000 tons carrying capacity by Hall, Russell, and Co., of Aberdeen, for the Leslie Steamship Company; also six steam trawlers by the same firm, making altogether a fleet of fifteen such vessels presently on hand.

THE MAIN DRAINAGE OF LONDON.

OUR readers will remember that in our issue of November 10th we gave a detailed account of the recent report of the Main Drainage Committee to the London County Council. This report was finally discussed on Tuesday last. Without going into details we may say that, practically speaking, all the recommendations of the Committee were adopted. There are to be two new sewers from Abbey Mills to the Barking outfall; another sewer between Deptford and Crossness, and a portion of another sewer laid over this new Deptford and Crossness sewer. The total estimated expenditure at present recommended is £1,250,000, and it is proposed to spread the work over eight years. When dealing with the report we asked the question, "Why take eight years over the work when on all sides it is admitted that it should be carried out at once?" Were it possible to do it quicker than that it would be better still. There is not a doubt about it that the outfall sewers are not big enough to deal with anything more than sewage flow. In quite a short time the capacity will not be big enough to take the flow, and then of necessity raw and undiluted sewage will once more find its way into the Thames in the heart of the City. Even now, so we understand, this happens occasionally. Perhaps it frequently does so even in dry weather. In any case, if it does not do so the least fall of rain will cause the discharge of what is practically undiluted sewage into the river. The Committee's report itself makes all this clear, and yet in spite of it all the vote was not passed without considerable opposition. We fail to understand the action of some members of the Council. There was an attempt to refer the matter back to the Committee, on the ground that the suggestions were unnecessary. "Not necessary"! Why, so far from being not necessary, they are puny in comparison with what should be done, and with what will have to be done, and done shortly, if London is to continue to hold its present position in the world. It is absurd, moreover, to talk of taking eight years over even this relatively small amount of work now proposed, and of not spending more than £200,000 in any one year. The relief is actually wanted now, and not at the end of eight years. For once, we can agree with Mr. Burns. He said he hoped the Council would say that the whole of the engineers' scheme, involving an expenditure of £3,000,000, should be carried out, and that as soon as possible. As a fact, the fear of their constituents has prevented the members spending more than £1,250,000, and for eight years things must continue getting worse with no practical relief.

IRONWORKERS' WAGES.

IT is satisfactory to know that workmen are fully sharing in the benefits of the present trade improvement. British employers alike, in the engineering and iron and steel trades are not the industrial nigger-drivers that some extremists among the trades unionists are so fond of alleging them to be. It is in times like the present that the working classes feel the benefit of our English sliding-scale systems, so essentially British in their principle of "fairplay all round." From this point of view the recent advances in ironworkers' wages in the North of England and in the Midlands form pleasant reading, as do also the figures as to improved selling prices, which make such advances possible. Of the reality of the trade revival no better evidence could be adduced than the recently-issued bi-monthly returns of the Wages Boards in these two chief iron and steel-making centres. Details of the uncommonly favourable North of England return—showing an advance in the average selling price of 37s. 4d. per ton over the minimum, an increase in production of 24 per cent. in two months, and a 2½ per cent. rise in wages—were given last week; and strong confirmation of the trade revival is now forthcoming from the Midlands also. The average selling price for September and October has been declared as £7 12s. 1·63d., or an advance of 8s. 6d. upon the return for July and August, and this increase would have been even larger had it not been for old contracts which had to be completed at comparatively low prices. Puddlers' wages are raised under the sliding scale from 8s. 9d. to 9s. per ton, which is equivalent to 2½ per cent., and millmen's wages are also raised in proportion. The Scotch steel operatives, who asked for a 10 per cent. advance, have accepted 5 per cent., but considering that the present rise is the sixth consecutive one, they would seem to have done very well even at that.

THE NEW FRENCH SHIPPING BOUNTIES.

A MEASURE has been laid before the French Legislature which proposes to modify the law of 1893 by the creation of an outfit bounty as an alternative to the navigational premium and the bringing of the bounty for steamers into line with that for sailing ships. In the abstract it would appear that, if bounties are going about at all, the largest measure of encouragement is due to steamers as the type of vessel which has the greatest possibilities of profit to the owner as well as to the country, and which is the vessel of the future even more markedly than of the present. The French authorities appear to have recognised this. At any rate it is proposed in the new Bill to make the rate for steamers uniform with the 1f. 70c. to sailing ships for every thousand knots traversed instead of 1f. 10c. as heretofore. The increased rate is only to be allowed on vessels constructed of iron or steel; but this is no hardship, seeing that wood has about served its purpose as a material of construction. The conditions are that the ships shall be of French build, and that when they are fifteen years of age they shall cease to draw the premium. The outfit bounty is to be 5c. per gross ton of steamers up to 2000 tons, decreasing 1c. per 1000 tons up to 4000 tons, and then remaining at 2c. It will be paid for twenty years from the launching of the steamer. Sailing vessels are to have only one-third of the sum allowed to steamers, and if their owners find the navigational bounty more profitable they will be at liberty to choose that. For the owner is at liberty in either case to choose the particular bounty which suits his pocket best. The Bill is certain to be passed, but we fail utterly to see that its provisions will do more than the existing law in adding to the tonnage of the merchant ships owned by the country.

SOCIETY OF ENGINEERS.

AT a meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, on Monday evening, December 4th, 1899, Mr. J. C. Fell, President, in the chair, a paper was read on "Water Supply to Country Mansions and Estates," by Mr. Gordon Harris, Assoc. M. Inst. C.E.

The author first pointed out that the subject of his paper presented features of interest in connection with minor water supplies. He observed that the cost of supplying an estate with water by the antiquated methods of either manual labour or uneconomical steam engines was very high. A gravitation scheme is far preferable, provided the source of supply is not too far distant. The objections to manual labour were pointed out, and pumping by animal power was considered more economical than by hand power. A small steam engine is not desirable on account of the heavy fuel bill and cost of attendance it involves. A gas engine can rarely be used in country mansions owing to the absence of a gas supply, but where gas is available a gas engine is very advantageous. The oil engine was strongly recommended as possessing every advantage as regards its fuel supply, its simplicity, and its economy in working. The author then gave the following comparison of the cost of pumping 1000 gallons of water to a height of 100ft. by various powers:—

(1) Hand labour at 18s. per week	26·5 pence
(2) Horse power, man at 18s. per week	4·20 pence
(3) Gas engine and pump, with gas at 4s. per 1000 cubic feet	1·44 pence
(4) Small steam pump and boiler, with coal at £1 per ton	0·75 pence
(5) Oil engine and pump, with oil at 7d. per gallon ..	0·70 pence
(6) Electrically-driven pump, worked from a lighting dynamo	0·45 pence

The cost of attendance is excluded in Nos. 3, 4, 5, and 6, as in some instances it may be negligible, although in No. 4 an allowance should be made varying in amount with the total daily supply and other conditions, and an addition must be made for coal used in getting up steam. As the cheapest and most lasting water raiser, the author stated that the hydraulic ram still retained its popularity. Water wheels, hydraulic pumps and windmills were also discussed and their respective advantages and disadvantages pointed out.

Examples were then given of the practical application of the mechanical agents referred to, and installations of various kinds on several estates and in large establishments were described and illustrated. Amongst other useful pumping appliances employed the "Hatfield" treble barrel pump manufactured by Merryweather and Sons was referred to. This pump can be driven at 700 revolutions or more per minute, and may therefore be coupled direct with an electric motor. It was stated that a number of these pumps is running in connection with water services, being driven by small high-speed oil engines as well as by electric motors. Another engine, known as the "Squire's," has also been designed for special use on estates, and is applicable to general purposes as well as for water supply.

The author next dealt with the question of well-boring, concerning which much useful information was given. The subject of locating water by divining was also touched upon, the author observing that some very curious successes had been achieved by that means, but at the same time he instanced a case in which he was consulted where the diviner's prediction had proved utterly valueless. The details of water supply, storage, filtration, and use were then discussed, and the most desirable apparatus for the various purposes involved were described. The supply of water to small villages adjoining large estates concurrently with that to the estate itself was also referred to, and its advantages under certain conditions were pointed out.

The important question of the utilisation of a portion of a water supply for fire-extinguishing purposes was next considered. The author observed that a large reserve must be secured for this purpose, and he described various arrangements of fire service that he had carried out in practice. These arrangements included gravitation and power systems. For meeting cases in which there is a deficiency of pressure, the author has devised a very efficient automatic pressure augmenter, which he explained. He then described the system of fire service adopted at St. Michael's Mount, Cornwall, recently installed by Messrs. Merryweather. In conclusion, the author observed that, failing the existence of the conditions necessary for a gravitation supply, or if the adoption of powerful machines was inadmissible for fire extinction, recourse must be had to the portable steam engine or to the less efficient manual engine, provided the source of supply was situate within a reasonable distance.

TANK ENGINES, BARRY AND PORT TALBOT RAILWAYS

THE COOKE LOCOMOTIVE WORKS, PATERSON, U.S.A., ENGINEERS

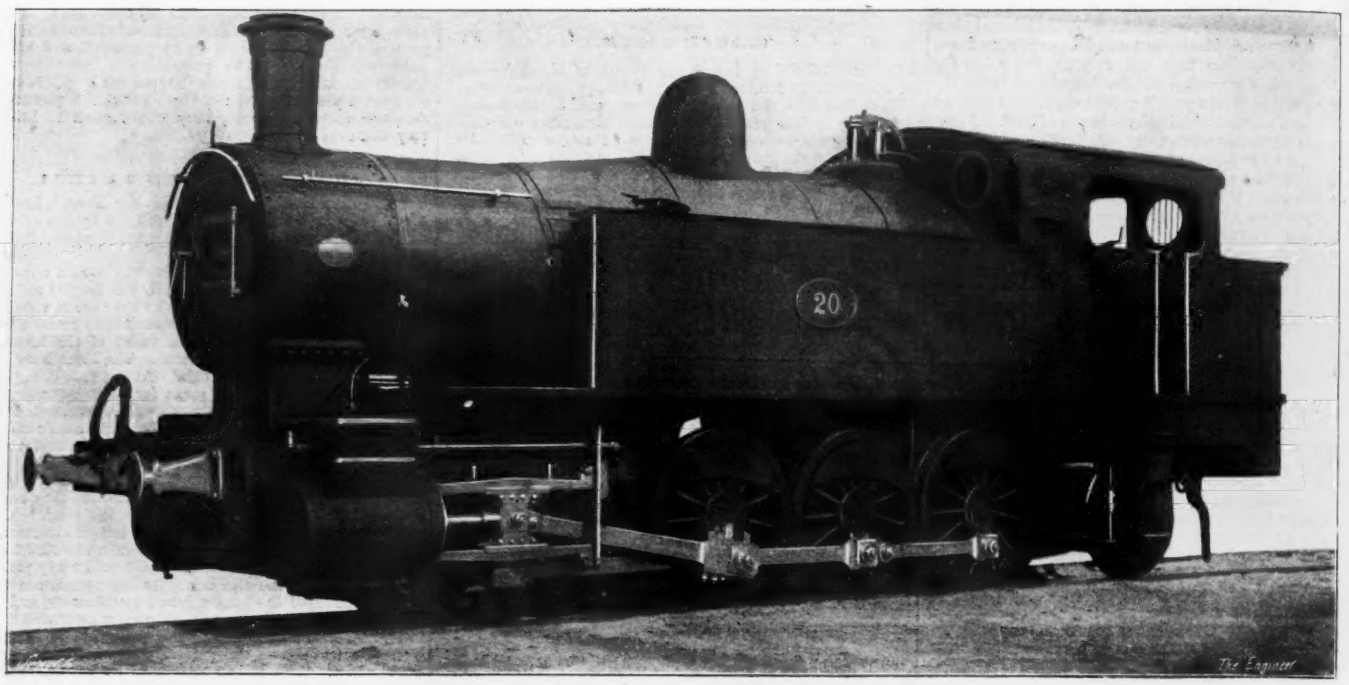


Fig. 1—PORT TALBOT RAILWAY LOCOMOTIVE

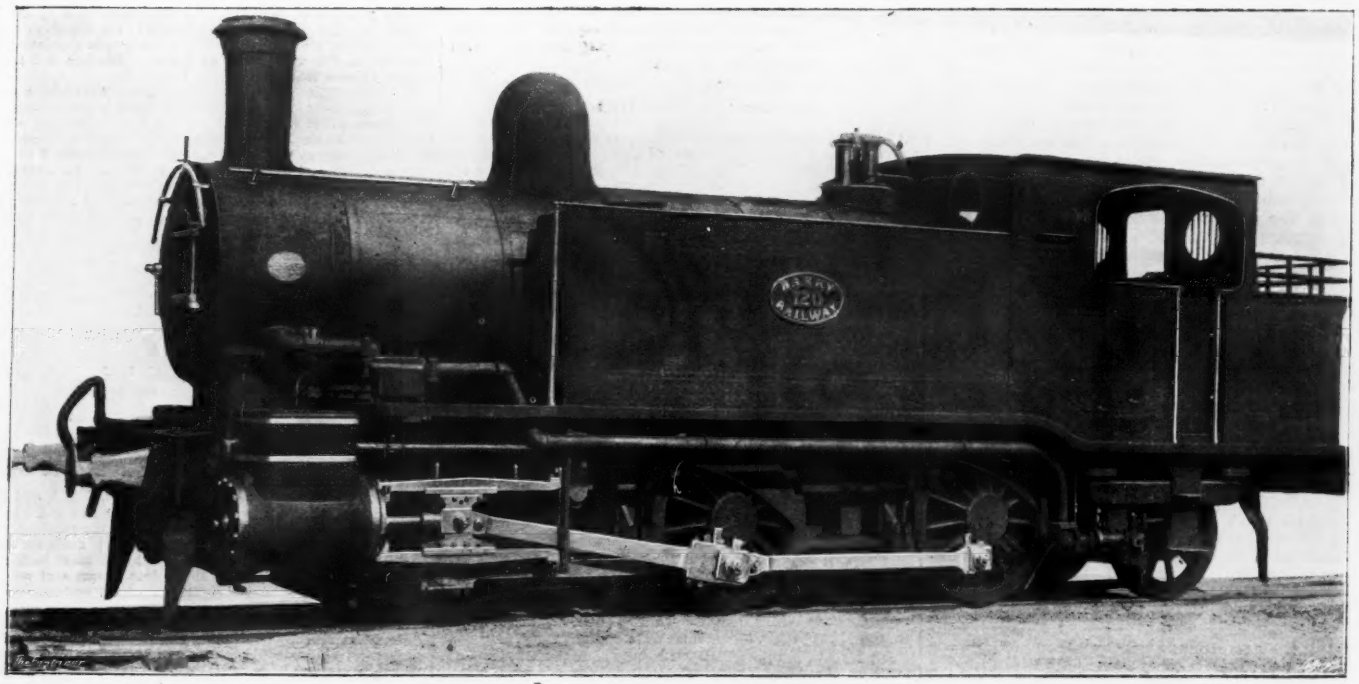


Fig. 2 BARRY RAILWAY LOCOMOTIVE

AMERICAN LOCOMOTIVES FOR THE BARRY AND PORT TALBOT RAILWAYS.

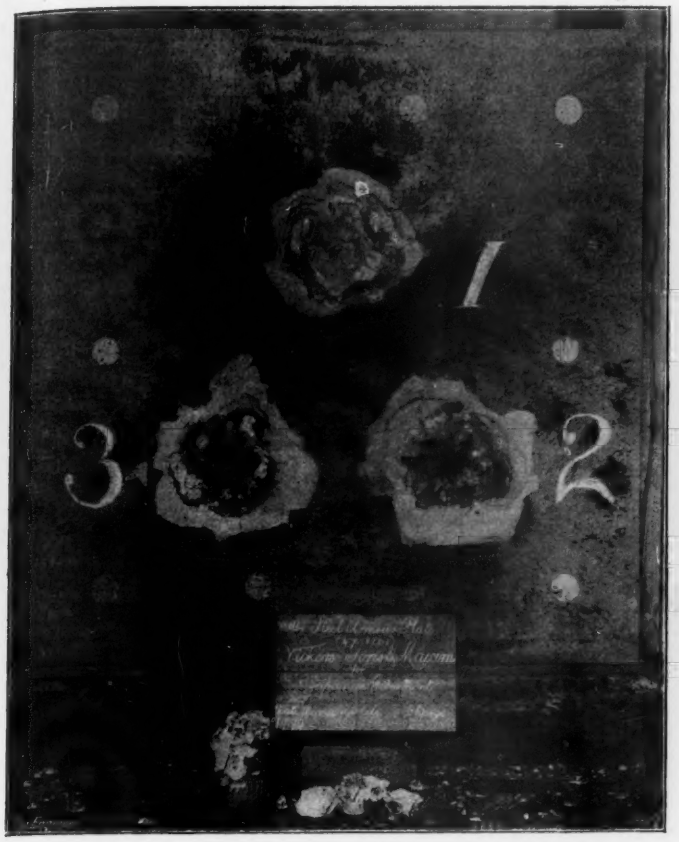
THE two locomotives which are illustrated this week go far towards proving the strong statements recently made by an American correspondent, and published in THE ENGINEER of September 29th, 1899, to the effect that American locomotive builders will build any sort of engine, and to meet any designs, specifications, or requirements. The engines, therefore, add force to the arguments that American builders will become very strong competitors of English and continental firms. The two engines in question are representative of ten engines recently built in the United States to the order of the Barry Railway and the Port Talbot Railway, both of which, as our readers well know, are in the South Wales district. At first sight the engines have a thoroughly English appearance, and, in fact, they were built to specifications and certain detailed plans furnished by the railway companies, while such fittings as were not obtainable in the United States were sent out from England. Side-tank engines are not used in the United States, the tank engines used for suburban service having a tank and coal bunker behind the cab. That fact, however, in no way deters the locomotive builders from building engines with side tanks for customers who prefer this style of construction. The specially American features are in the crosshead and guides, the slide valves and valve gear, the cylinder saddles, and the "wagon-top" boiler of the Port Talbot engine. There are no equalising beams connecting the driving springs—which is one of the essential features of American practice—while the vacuum brake fittings, the exhaust steam injector, and the Ramsbottom safety valves are not used in America, and were sent out from England, as were also the spring buffers and the lubricators. In the cab the regulator handle is arranged according to English practice. The main frames are a combination type, the American bar frames being used from the buffer beam to the fire-box, while short plate frames carry the rear tank and coal bunker.

The Port Talbot Railway engine, Fig. 1, is a powerful machine and has the more foreign appearance of the two, owing mainly to the shape of the boiler, while eight-coupled engines are still somewhat exceptional on English railways. All American engines, however, except shunting engines and some suburban tank engines, have a leading two-wheeled or four-wheeled bogie and a pilot or "cowcatcher" as well as a headlight in front of the funnel. The sand box, too, is almost invariably placed on top of the boiler. The cylinders and saddles are of American design, with the slide valves on top of the cylinders, and having the valve rod operated by a rocker, which may be seen just behind the motion plate or guide yoke which supports the ends of the slide bars. The form of deep crosshead and widly-spaced slide bars represent a form of construction very generally but by no means universally used. Shallow crossheads working within four slide bars and crossheads supported from two overhead slide bars are other equally common forms of construction. In accordance with English requirements, brass is used for the tubes, and copper for the fire-box. The grate is of the rocking finger pattern. The short smoke-box, the funnel, dome, safety valves, cab, tanks, and radial axle for the trailing wheels, are all distinctly English in design.

The Barry Railway engine is very similar in general design to the one above described, but is even more distinctly English in appearance, having the ordinary form of straight top boiler. The large pipe under the tank is that for the Davies and Metcalf exhaust steam injector, which is placed just behind the smoke-box—this is an English injector. The large flat pipe behind the steps connects the tank under the coal space with the side or wing tanks. The fire-box is of copper, with stationary grate-bars, and the tubes are of brass. The valve motion is the same as in the other engine, and the slide valves are of the Richardson balanced pattern, with Allen ports from end to end of the valves. The short smoke-box has a single low-blast nozzle, and there is no netting to arrest sparks. The boiler is built of $\frac{5}{16}$in. steel, put together with double-riveted butt joints, with $\frac{7}{8}$in. rivets. The fire-box is set between the frames, and is of $\frac{1}{2}$in. sheets, except that the tube plate is 1in. thick, while the steel smoke-box tube plate is $\frac{3}{8}$in. thick. The depth inside is from 5ft. 9in. at the front to 4ft. 4in. at the back. The wheels have cast steel centres, with Latrope steel tires shrunk on and secured by bolts, the main driving wheels having bald tires. The United States metallic packing is used for the piston-rods and valve stems. The steam gauges are American, of the Ashcroft make, while the lubricators are English, made by the Vacuum Oil Company. The funnel is from 16$\frac{3}{4}$in. to 19$\frac{1}{4}$in. diameter, and its top is 13ft. above the rails, while the centre of the boiler is 7ft. 6in. above the rails.

The engines were built by the Cooke Locomotive Works,

ARMOUR PLATES FOR JAPAN



of Paterson, U.S.A., the order having been placed through their English agents, the firm of Evans and O'Donnell, 7, Palace Chambers, Westminster. The leading dimensions and other particulars of these engines are as follows:—

	Port Talbot Railway.	Barry Railway.
Gauge	4ft. 8½in.	4ft. 8½in.
Cylinders	19in. by 24in.	18in. by 24in.
Driving wheels	4ft. 4in.	4ft 3in.
Trailing wheels	3ft. 6in.	3ft. 6in.
Total wheel base	22ft. 1in.	20ft. 1in.
Driving wheel base	15ft. 6in.	14ft 5in.
Journals of driving axles	8in. by 8⅞in.	8in. by 8⅞in.
Journals of trailing axles	6½in. by 9½in.	6½in. by 9½in.
Boiler, pattern	Extended wagon t op	Straight top
Boiler, diameter of first course	4ft. 8in.	4ft. 5⅝in.
Boiler, diameter of dome	2ft.	2ft.
,, shell plates	—	½in.
Working pressure	175 lb.	160 lb.
Fire-box, length	7ft.	6ft. 7in.
,, width	3ft. 6in.	3ft. 4½in.
,, grate area	24½ square feet	21 square feet
Tubes, number	219	181
,, diameter	2in.	2in.
,, length	1 ft 11in.	11ft 2½in.
Heating surface, tubes	1361 square feet	1049 square feet
,, ,, fire-box	128 square feet	98 square feet
,, ,, total	1489 square feet	1147 square feet
Steam ports	1⅛in. by 17in.	1⅛in. by 17in.
Exhaust ports	3in. by 17in.	3in. by 17in.
Slide valves, travel	5½in.	5½in.
,, ,, lap inside	Line and line	Line and line
,, ,, lap outside	⅞in.	⅞in.
Rail to centre of boiler	7ft. 11½in.	7ft. 5½in.
Rail to top of funnel	13ft. 2in.	13ft.
Capacity of tank	2000 gallons	1600 gallons
Capacity of bunker	2 tons	1¾ ton
Weight on driving wheels	137,000 lb.	100,000 lb.
Weight on trailing wheels	32,000 lb.	26,000 lb.
Weight, total	71 tons	56 tons

DOCKYARD NOTES.

IN this week's *Le Yacht* Lieutenant Emile Duboc has an article upon naval policy and the French naval programme. The author of "*Le point faible d'Angleterre*," after bewailing the fact that wicked England will not allow France to exist in the peaceful neutrality that she loves, discusses the possible coming war, and the folly of building a couple of big battleships, to meet which England is certain to lay down three. He says eighteen would be needed, but that, if eighteen were built, England would alter her programme to meet them. Consequently, it is useless for France to build ironclads. From ironclads he passes to the submarines, but only sees limited salvation there. Cruisers are his panacea, and though he does not say so in so many words, bases for these cruisers so protected by submarines that it will be impossible to blockade them. The ironclads must not fight under any circumstances, he thinks. Replying to an anticipated objection that England can and would outbuild France in cruisers, he urges that the ocean is a big place, and that, since our cruisers would all be separated, numbers would give them no advantage.

WE confess to finding some difficulty in following this. If, for the sake of argument, there are 150 English and fifty French cruisers, and fifty single-ship actions took place, even if the French won all or nearly all of these, the victors would be little better off than the vanquished, and fall victims to the other hundred English cruisers. The more cruisers we have, the more they will meet; and though the ocean is big, the trade routes are very narrow. There are certain points at which trade must pass, and if it is to be seriously attacked, it must be attacked at those points. At these our cruisers are certain to be met. The greatest difficulty of all, however, the lieutenant does not refer to. He does not make enough allowance for human nature. The French are no cowards, and the ships that they have—policy or no policy—will certainly bravely try conclusions with ours. They have, moreover, one excellent remedy, and that is not to make war on this country; they could get quite as much amusement out of "pin-pricks" on Portugal, Spain, or Greece, and it could be done far more economically.

THREE armoured cruisers of 13,500 tons and 18-knot speed, three protected cruisers of 8000 tons, is the fighting part of the new United States naval programme. The rest are gunboats for police duty. The Americans are evidently shaking off the "moderate dimension" craze, to which a few years ago they were disposed to adhere. It is rumoured that the 13,500 ships will be more or less after the style of the Russian Peresviet type, a very powerful sort of armoured cruiser, equal to a first-class battleship in everything save the power to deal vital blows.

THE British armoured cruiser Cressy, a sister to the Sutlej, has been launched by the Fairfield Company.

FOUR 10·8in. guns, 45 calibres long, of the latest model, are being mounted in the maindeck battery of the French Dévastation, a sister to the Courbet. In order to reinforce the battery armour, thick shields are being supplied to these guns—rather a waste of armour seemingly. Still only a big A.P. shell can penetrate the redoubt, except through a port. An idea of stripping the old armour and putting Harveyised plates in its place, mooted some while since, does not seem to have come to anything. The mainmast of the Dévastation was removed some while since, and there are now no three-masted battleships in the French navy, though one or two old armoured cruisers still retain the three.

THE Russian ironclad Apraksin is reported still aground, and in a very dangerous position. The new armoured cruiser Gromovoi also grounded—in the channel dredged from Petersburg to Kronstadt—but this was a small affair. She was got off again none the worse and taken to Kronstadt to be completed for sea.

THE whole of the Russian Baltic fleet available for sea—that is, the Poltava, Sevastópol, Peresviet, Seniavin, Oushakoff, and Svietlana—will, it is said, winter at Libau this season, so that they can be despatched to the Far East if necessary.

THE Particular Service Squadron is using no electric light on the trip to Gibraltar, so as to economise coal. It is understood that this will be the rule in war-time, but such an order has never before been issued. If people want to scent something in the wind, a first-class opportunity presents itself here.

THE Canopus was commissioned on Tuesday, the 5th December.

VICKERS' ARMOUR FOR JAPAN.

IN our issue of September 8th last we mentioned the trial of belt armour supplied by Vickers, Sons, and Maxim, Ltd., to the Japanese man-of-war Shikishima, building at the Thames Ironworks. We are now able to give a photograph of the results of the trial. The plate was 8ft. by 8ft. by 8¾in. It was termed a special nickel Harveyed plate, probably differing only in detail from the admirable Krupp process plates made by Vickers for our own Government. The attack consisted of three rounds with 9·2in. armour-piercing steel Holtzer projectiles. Two rounds were delivered with a velocity of 1700 foot-seconds, and the third with 1800 foot-seconds velocity. Each projectile weighed about 380 lb. By Tresidder's formula the penetration through wrought iron is 17·1in. for the first two rounds, and 18·6in. for the third, the tests implying a figure of merit of 1·95 and 2·13 respectively. As the projectiles, far from perforating, only penetrated to a depth of 3in. and 3¾in., the plate had a much higher figure of merit; but we cannot say what it was. Our engravings show the front and back of the plates after the third round. The shots have evidently been thoroughly broken up. In the large official photograph a trace of white radiating lines is visible, and these always imply extreme disintegration, being the mark of langridge skimming over the plate face. There are no cracks. As most of our readers are aware, the Japanese are having built for them very powerful ships of war, on the pattern of our heaviest. One, the Mikase, building at Barrow, appears to be more powerful than anything afloat.

ALTITUDES OF RAILWAYS ABOVE SEA LEVEL.

WE propose in the following short article to give some interesting particulars of altitudes attained by the principal railways in different parts of the world. As it would be tedious to our readers to p ace these details before them in the body of the text, we shall give them in a tabular form, which will enable them to be the more readily compared and appreciated. It might be supposed that the rack railways would head the list, but though they run the others very closely, it will be

TABLE I.—*Rack Railways.*

Name of railway.	Maximum altitudes in feet above sea level.
Pike's Peak, U.S.	13,200
Görner-Grat	10,065
Jungfrau	7,613
Rothorn	7,425
Pilate	6,850
Rigi	5,578
Monte Generoso	5,280
Gaisberg	4,248
Semmering	2,912

seen from Table II. that they do not quite bear away the palm. There are three lines which may be referred to independently of those scheduled in the tables, as they are laid out partly on the rack and partly on the ordinary steam traction system. These comprise the lines between Beyrouth and Damas and between Eisenery and Vordenborg. They are both in Styria, and attain each an altitude 3960ft. above the same datum. The State railway from Herzegovina to Bosnia, belonging to the same system, reaches to a height of 2904ft. above sea level. It will be advisable to tabulate the other lines, which are ordinary locomotive railways, under two heads, viz., those which belong to Europe and those which are situated in foreign countries.

TABLE II.—*European Railways.*

Name of railway.	Maximum altitudes in feet above sea level.
Land-quart to Davos	5,390
Kaltlad to Scheidegg	5,201
Brenner	4,494
Guadarrama, Spain	4,433
Mont Cenis	4,290
Lloran, France	3,800
St. Gothard	3,811
Alais to Brionde, France	3,395

It should be mentioned that the first two lines in Table II.

are both located in Switzerland, and have a gauge of one metre.

TABLE III.—*Railways in Foreign Countries.*

Name of railway.	Maximum altitudes in feet above sea level.
Central Peruvian	14 555
Chilian and Bolivian	13,0 8
Denver and Rio Grande	11.385
Vera Cruz	9 042
Union Pacific	8,292
Canadian Pacific	5 940
Northern Pacific	5,610

The highest altitude to which a cable line has attained is that of one near Stanserhorn, which rises to 6100ft. It will be observed that with the exception of the Pike's Peak rack railway, the lines which traverse the passes of the Andes, in South America, can give the others a wide berth, although some of them can boast of very respectable figures.

LETTERS TO THE EDITOR.

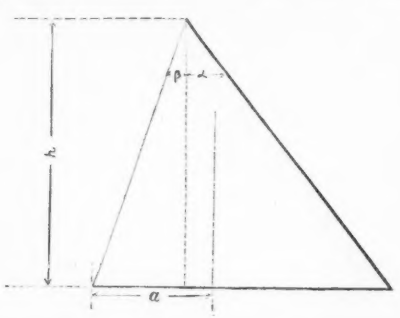
(We do not hold ourselves responsible for the opinions of our correspondents.)

STABILITY OF LOW MASONRY DAMS.

SIR,—The following is interesting, especially as the final formulæ are of great simplicity. By a low dam is meant a dam in which considerations of stability only are involved in its design. The conditions necessary for a low masonry dam are the same as those required for the topmost portion of a high masonry dam. This portion is designed only for stability, and is carried down to a depth at which the maximum stress to be imposed on the masonry is reached. Below this depth the side slopes of the dam are flattened out to avoid the maximum allowable stress being imposed on the masonry. Stability being then ensured by the more rapidly-increasing width of the base, is no longer considered in the design for the lower portion of the dam.

At the present day masonry dams are designed on the assumption that, in order to avoid tensile stress in the masonry when the reservoir is either full or empty, neither the resultant due to the weight of the masonry when the reservoir is full, nor the resultant due to the pressure of the water plus the weight of the masonry, shall fall outside the middle third of the width of the dam at any horizontal section. On this assumption engineers have established a triangular section for low masonry dams, with a vertical back face and a slope to the front face, so that the two resultants—reservoir full and reservoir empty—fall exactly on the outside limits of the middle third. A small triangle of masonry is then added to the apex of the main triangle to give a suitable top width.

The following is an investigation to find the dimensions of triangular masses of masonry, such that the two resultants shall fall on any required central portion of the width of the dam lying within the middle third—such as the middle fourth, middle fifth, &c. The result of this investigation, though perhaps of no great utility, is of mathematical interest, and may be of some use to those who have not sufficient confidence in the ordinary assumptions.

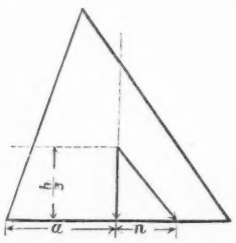


Take any triangle of masonry of height h, as in the above figure, whose slopes are inclined at angles α and β to the vertical, on the down-stream and up-stream sides respectively. The vertical, through the centre of gravity of the mass, is at a distance a from the inner face. It will be found that

$$a = h\,\frac{(\tan\alpha + 2\tan\beta)}{3} \quad . \quad . \quad . \quad . \quad . \quad (I.)$$

Let w = unit weight of water,
w_m = unit weight of masonry.

Neglecting the vertical pressure of water, the forces are (1) the weight of the masonry = $\frac{w_m h^2}{2}(\tan\alpha + \tan\beta)$, acting at a distance a from the inner edge of the dam, and (2) the horizontal pressure of the water = $\frac{w h^2}{2}$, acting at a height $\frac{h}{3}$ from the base of the dam.



Taking the triangle of forces, we have the following ratio:—

$$\frac{n}{h} = \frac{\frac{w h^2}{2}}{3\left\{\sqrt{\left(\frac{w_m h^2}{2}(\tan\alpha + \tan\beta)\right)^2 + \left(\frac{w h^2}{2}\right)^2}\right\}}.$$

Where n = the distance between the two resultants at the base of the dam, or

$$n = \frac{h}{3}\cdot\frac{w}{w_m(\tan\alpha + \tan\beta)}.$$

Or if ρ = the specific gravity of the masonry

$$n = \frac{h}{3\rho(\tan\alpha + \tan\beta)}. \quad . \quad . \quad . \quad . \quad (II.)$$

But for n to be central we must have

$$h(\tan\alpha + \tan\beta) = 2a + n.$$

By substituting the value of a from equation (I.) and n from equation (II.), we get the equation

$$\tan\beta = \sqrt{\frac{\rho\tan^2\alpha - 1}{\rho}}. \quad . \quad . \quad . \quad . \quad (III.)$$

We wish, however, the resultants to fall on the limits of a definite fraction of the width = k say, k being equal to

$$\frac{n}{h(\tan\alpha + \tan\beta)}.$$

On replacing k for n in equation (II.), we find

$$\tan\alpha + \tan\beta = \pm\sqrt{\frac{1}{3\rho k}} \quad . \quad . \quad . \quad (IV.)$$

Minus values to the right-hand term are obviously absurd, from practical considerations. If we therefore substitute the positive value to the above equation, and with equation (III.) eliminate $\tan\beta$, our final equations are

$$\tan\alpha = \frac{1 + 3k}{2\sqrt{3k\rho}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.)$$

$$\tan\beta = \frac{1 - 3k}{2\sqrt{3k\rho}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (VI.)$$

Bouvier's formula for the maximum stress on the outer toe, reservoir full, is

$$p = 2\left(2 - \frac{3e}{l}\right)\frac{R}{l\cos\theta}. \quad . \quad . \quad . \quad . \quad (VII.)$$

Where p = maximum pressure on outer toe.
R = resultant pressure on base.
e = distance of R from the outer or nearer edge.
θ = angle of inclination of R from a vertical line.
l = width of base.

But $e = \frac{l(1-k)}{2}$.

$l = h(\tan\alpha + \tan\beta)$.

and $$\frac{R}{\cos\theta} = \frac{w_m h^2}{2}(\tan\alpha + \tan\beta) + \frac{\left(\frac{w h^2}{2}\right)^2}{\frac{w_m h^2}{2}(\tan\alpha + \tan\beta)}.$$

By substituting these values in equation (VII.), together with the proper values of $\tan\alpha$ and $\tan\beta$, we find the maximum pressure

$$p = \frac{w h(3k+1).(3k+\rho)}{2} \quad . \quad . \quad . \quad . \quad (VIII.)$$

So that the maximum height to which a dam, of the form given by equations (V.) and (VI.), may be carried without exceeding the maximum allowable stress (ρ), is given by the equation

$$h = \frac{2p}{w(3k+1)(3k+\rho)}. \quad . \quad . \quad . \quad . \quad (VIII.)$$

In the above equations I have neglected the vertical pressure of the water, for if this be included the final equations become much involved. By adding the weight of the water, the resultant is brought towards the centre of the dam; so that, while the total weight is increased, there is a tendency for the stress at the outer toe to be reduced. The above formulæ are therefore approximate, and for all values of k between $\frac{1}{3}$ and $\frac{1}{5}$ are accurate enough for practical purposes.

Birmingham, November 20th. H. WALTHORP.

ELECTRIC LIGHTING AND REFUSE DESTRUCTORS.

SIR,—I have read with great interest your salutary remarks on this subject, also the various opinions of your correspondents—the more so because last year I pointed out discrepancies in the statement made respecting the Shoreditch scheme, which at that time was not relished by the authors, but which criticism is now admitted to be correct, and which your article also tends to confirm. In 1893 the Vestry was advised by reports from Messrs. Elliott, Paton, and Ransom, that a revenue of £4290 might be expected from the use of a destructor for steam-generation, mortar, and available clinker, with a maintenance inclusive of depreciation, interest, and all contingencies, of £2900, and that the cost of the disposal alone should not exceed 1s. 6d. per ton.

Mr. Manville told the Vestry that, for 20,000 tons of ashbin refuse to be utilised, the annual cost would be £1250, or say 1s. 3d. per ton; therefore the Vestry were led to expect big things by their advisers, and it becomes the more interesting to compare with these statements the real maintenance costs and efficiencies. I note that you say that 23,728 tons of refuse were incinerated at a total cost of £8364, or, without repayment of capital, £7384; but this amount includes the stoking of about 1450 tons of coal, which I will liberally allow for at £500, so that, deducting this amount, the cost of maintenance for refuse only would be £6884, which is 5s. 9d. per ton; but with the repayment of £980, which is the equivalent of depreciation, is 6s. 2d. per ton. Having regard to this wide divergence in the estimates, I propose to analyse somewhat the costs of maintenance in the published accounts in their chief items, with a view to ascertain where the leakage exists.

The first and heaviest item that meets the eye is £3146 for wages and management, but from this item I propose to deduct coal stokers' wages, estimated at £500, thus leaving £2646, or 2s. 3d. per ton. This, in comparison to many destructors being worked for 1s. 6d. to 1s. 9d., appears extravagant. Another item is the cartage of clinker. From 23,728 tons put through the furnaces, 12,225 tons of clinker and ash were carted away at a cost of £1460, so that 11,503 tons of refuse were destroyed, their residuals forming more than half the total quantity put through the furnaces. I am quite prepared to admit that the growing cost of the disposal of refuse in London municipal areas demands the better and more expeditious means of disposal by fire, especially also for sanitary reasons; but to say that the total cost of 6s. 2d. per ton as against 3s. per ton by barging is a burden to be borne without an endeavour to obtain an increased efficiency, is not meeting the question from an engineering standpoint, as the fuel value, even at Shoreditch, is no mean item, as one penny per unit for the coal consumed leaves a fuel value of £3943 for the refuse. Therefore, with an economy of £3921 in the costs of working, a combined undertaking of electrical lighting and refuse destruction would not be a burden on the ratepayers, but a financial success, besides contributing to better conditions of health. In order to accomplish this it appears, in my humble opinion, to be necessary to have complete combustion of all the material, to leave 33 per cent. of residuals only, which is frequently done, and with the best mechanical means to prevent cold air reaching the furnaces during clinkering and stoking; therefore a higher temperature in the furnace may be obtained, when steam at a higher pressure will be generated, and the residuals reduced to simply incombustible matter. This result would leave only the 33 per cent. to be barged or otherwise disposed of—probably by being a better burnt clinker—at a profit, and the large bulk of material, viz., 10 tons per day, to be stoked to each furnace demands a complete mechanical handling to prevent a heavy wages maintenance.

Thermal storage, or a conservation of heat during light demand, is also absolutely necessary to efficiency. These improvements would bring down the costs to not greater than the old system of barging, and prevent an increase of the rates, as is the case at Shoreditch. J. W. BAKER.

7, Broad-street House, E.C., November 29th.

ECONOMICAL HAULAGE.

SIR,—You very pertinently say that almost anything can be proved by the proper use of figures. I have been reading with care, I suppose everything that has been published in the country, and much of what has been said in the United States press about railway work, and I have come to the conclusion that while we have general information in plenty, there is little detailed information to be had. Your leader is quite to the point about this.

I do not intend attempting to go into the matter at any length, but with your permission I want to ask Mr. Acworth for a little information.

You gave the receipts for a 2500-ton train net as £2 12s. 1d. per mile. Mr. Acworth does not regard such a train as anything out of the way. Indeed, he speaks of trains much heavier. Then he tells us that 96,000 miles per annum would not be far out of the way for an engine. I must make an allowance, I suppose, for returned empties. I will take 75,000 as paying mileage. Now, 75,000 × £2 12s. 1d. = £201,250 as the sum earned every year by one locomotive. I think these figures quite fairly represent the outcome of Mr. Acworth's argument. I want to know if he has checked these figures in any way, because they appear to me to be impossible. They are out of all proportion greater than anything done by any other form of machinery in the world.

I may, perhaps, say here that I have some experience of prices in the locomotive trade, and I am sure that your estimate of £5000 as the cost of the engine would be altogether under the mark at the present prices of materials; but taking £5000 as right, and deducting 10s. a mile for the working expenses of the engine, we have left £166,250. It appears that the engine will pay for itself 33,250 times over in the course of a year.

Again, dividing the net earnings by 365 days, we find that the locomotive earns every day in the year £454. This seems a highly profitable transaction. The only wonder is that the companies cannot afford to carry at much less than one farthing per mile. Perhaps when Mr. Acworth reads these figures he will see reason to modify his statement. In fact, engine mileage is a very loose term, and it does not supply anything like a complete basis on which to calculate earnings. I have worked out the statements of your correspondent to their logical conclusion, which seems to me to give preposterous figures. In this, however, I may be mistaken; but Mr. Acworth, as the advocate of American system of working, has here an unparelleled opportunity of showing how railway companies can make money. If he can prove that facts demonstrate that locomotive engines costing under £5000 can earn each £166,000 a year, he ought to sweep all opposition before him. The notion of the London and North-Western Railway earning over £300,000,000 per annum is enough to make one's mouth water. Mr. Acworth will perhaps say that all this is nonsense. Are we to conclude, then, that after all these big mileages and big trains are not quite what they seem to be? AXLE BOX.

Willesden, December 4th.

SIR,—One or two points occur to me, which may help forward your timely discussion of this subject.

As to the mileage of United States locomotives, I have a photograph of one of the powerful express engines of the Vandalia line, which are given hard work in hauling fast trains of great weight, with much more frequent stops than like trains in Great Britain, and along with it official figures showing that these locomotives do a round trip of 476 miles each day, and have run in this service as much as 14,610 miles in one month, or at the rate of over 175,000 miles per annum. It has long been evident that we do not get anything like a properly economical mileage from our locomotives.

As to the speed of the heavy freights on the Illinois and such lines, you write of ten miles an hour as if it were a maximum speed. The ten miles an hour spoken of by your American contemporaries is, I think, an inclusive speed, and these trains must run up to twenty or twenty-five miles an hour to maintain this, especially as 3350 tons cannot be brought to speed in a short space of time.

This leads me to touch on one more point. You are struck by the probably destructive effects on the track by locomotives having 22 tons weight per axle, but writers in this country forget that the tracks for these engines have no chairs, and in consequence weights and speeds combined can be used on them which would pound our antique and unscientific tracks into excellent "scrap." Moreover, we must take into account the high state of perfection which our cousins have reached by careful experiments in the matter of balancing, and compensating springs and levers for locomotives. NORMAN D. MACDONALD.

Edinburgh, December 4th.

SIR,—Mr. Acworth, in your last impression, gives the mileage of an American freight engine at 8000 a month. This gives an average of 266 miles a day. This means that it must run continuously at an average speed of over eleven miles an hour for every hour in the twenty-four, and every day in the year, save some half a dozen.

Your correspondent will add to the value of his letter if he will explain how this is done, and what he means by engine mileage. In this country the words are used in a very lax way.

Birmingham, December 4th. W. H. REED.

THE TRAINING OF ENGINEERS.

SIR,—The short article headed "Grievances of Young Engineers," in your issue of the 24th inst., seems to give an opening for discussion as to the present methods of training engineers in this country. Professor Ewing is reported to have said that the young engineer generally had to pay dearly for his workshop training; he might have said exorbitantly. Let me give a typical instance. Probably one of the best professional trainings is to be obtained by spending three years at a good technical college, and then three years' at some large works, such, for example, as the works of one of the leading railway companies.

At the age of twenty the young engineer leaves college with a certain amount of knowledge that has an immediate value to an employer. In fact, if he has made good use of his college training, he is at least "worth his bread and butter," as Professor Ewing put it. At the same time he is urgently in need of experience of the management and organisation of large works, of shop methods, and of the habits and customs of workmen, &c. Under these circumstances, if he gives his services gratuitously for two or three years in exchange for the experience he is acquiring, the employer should have by no means the worst of the bargain. In practice, the young engineer is expected to pay about £450 for his three years' experience. I consider such a price exorbitant. One thing is certain, that the young engineer, after having spent at least as much time, and considerably more money, than are required to become qualified in other professions, finds it very hard to sell that somewhat indefinite commodity for which he has paid £450. Moreover, he has, at the end of his six years' training, no definite status in his profession, as compared with a solicitor or a doctor. At present pupils are apparently regarded more as the lucrative perquisites of the chief positions in large companies than as the specially selected material for the formation of a staff of skilled engineers. A. K. C.

London, November 28th.

[A great firm in the North, being overwhelmed with applications by would-be pupils, raised its premium to one thousand guineas in order to keep applicants away. The result has not been that which was anticipated. The question raised by Professor Ewing and "A. K. C." is very large. Our correspondent ought to know that numbers of eminent firms taking pupils will have nothing to do with premiums. In fact, the premium system is very far from being universal, as "A. K. C." seems to imagine.—ED. E.]

SUGGESTIONS AS TO A TIDAL CANAL NEAR PANAMA.

SIR,—In the year 1843 I was serving in her Majesty's steam sloop Salamander, Captain Hammond, the first English steam man-of-war that navigated the Pacific Ocean.

In that year we called at Panama, and remained there some two months. In those days the desirability of constructing a canal and a railway to facilitate traffic between the Atlantic and Pacific

was talked about, and from that time to the present the subject has much interested me. Years afterwards, when commanding her Majesty's brig Sappho, say, in 1851, I was employed several months as senior officer at Grey Town, which is situated at the mouth of the river leading to the Lake of Nicaragua, the political outlook was very complicated, and the rush of emigrants to the gold fields of California over the Nicaragua route was enormous. To give an idea of the energy displayed, I saw the keel of a stern-wheel steamer—about 100ft. in length—laid, and in, say, four weeks, she was built, engined, launched, and steaming about the harbour.

I also visited Bluefields, a site much spoken of at one time as the Atlantic terminus of an Isthmus Canal; for the ability and discretion I displayed I received the commendation of the Foreign-office, of the Admiralty, and of the Commander-in-Chief. Subsequently, when Commander-in-Chief on the Pacific station, say, 1873-76, I visited several of the anchorages or ports suggested for the terminus of the Isthmus Canal. I also visited the Lake of Nicaragua. I was detained several months at Panama, and crossed over the Isthmus by the railway several times. I became so impressed with the almost insuperable difficulties of making a canal between Panama and Colon, that on my return to England I obtained permission to have my views inserted in the *Journal* of the Royal Geographical Society, of which society I had been a member many years. The letter, by the courtesy of the society, was inserted in an early issue, and would have appeared in the final issue, had I not withdrawn it, as a meeting had been called of the Royal Geographical and other learned societies, at, I believe, Plymouth, at which M. De Lesseps and other able persons were to lecture on the desirability of cutting the ship canal at Panama, and I deemed it would be presumptuous and inopportune on my part to oppose my humble opinion to that of M. De Lesseps and his staff of skilled engineers.

My object in now addressing you is to say that when detained at Panama, say, in 1876, I was desirous of visiting the narrowest portion of the Isthmus, which is about twenty-five miles to the eastward of Panama, and of a width of about twenty-nine miles, and is conterminous with the mouth of the river Chepo on the Pacific side and the port of San Blas on the Atlantic side; the length of the Panama Canal is said to be about 46 miles. I ascended the river Chepo in a steam launch for some miles, remained at a village for the night, caused celestial observations to be made, and it was stated that we were only some fifteen miles from tidal waters on the Atlantic side; and had circumstances permitted, we would have ascended the river Chepo several more miles still within the tidal influence of the Pacific waters. The tides at Panama are heavy, and rise perhaps 20ft.

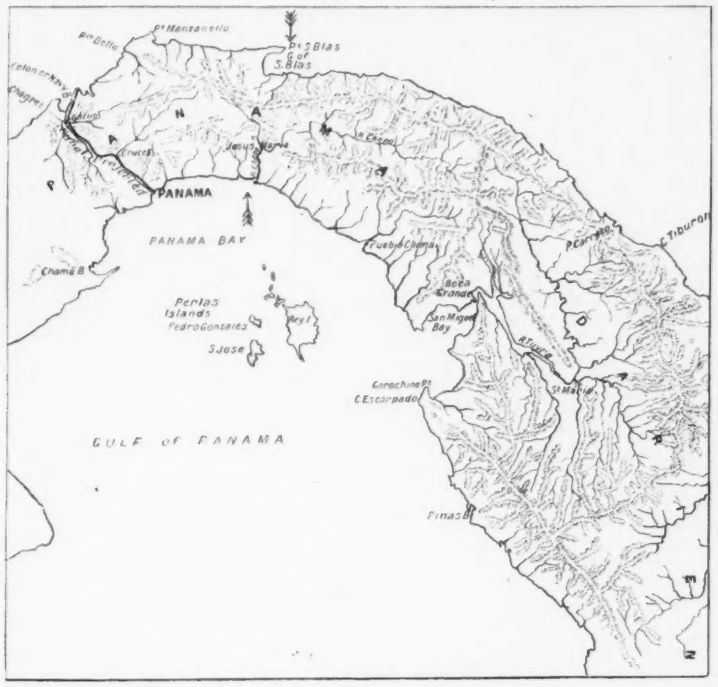
I suggest that disinterested persons should be sent to examine the locality I have named as to its suitability for a canal. Ranges of hills were noticed beyond the point we reached, but they might perhaps be turned, or some tunnel or tunnels driven through them, through which ships might be taken, not by using their own steam machinery or steerage powers, but by haulage or towage; the masts and funnels of such ships would, of course, be unshipped. A few spars projected from the bows and quarters of the ships, and fitted with large grooved rollers, and these made to run against an iron rail above water and secured to the side of the tunnel would ensure that "the ship's side would be kept parallel, and free from contact with the sides of the tunnel." Without such device were used, the safe passage of ships through a tunnel perhaps several miles in length, and only a few feet broader than the ship, would be hopeless.

Should such canal, "and with narrow tunnels," be completed, whether at Panama or San Blas, it would be a tidal canal—like the Suez Canal—involving the minimum of delay to ships. The Nicaragua Canal would be immensely longer, say, of a total length of 175 miles; ships would have to be lifted to the level of the lake—some 212ft.—and let down an equal distance on the Pacific side of the lake. There is, besides, a group of volcanic islands in the Lake of Nicaragua, which erupt at times, and a movement of the ground in an earthquake of, say, a few inches, would utterly disorganise the very numerous lock gates required. The rise and fall of the lake as between the wet and dry season is some 12ft., another element of trouble.

I might mention that in 1858, having been severely and badly wounded on four occasions in the war in China, I was invalided home for the preservation of my life, and passing through Egypt saw the site of the present Suez Canal, which was not then in existence.

ARTHUR A. COCHRANE,
November 29th. Admiral.

[We give a small sketch map in which the termini of Admiral Cochrane's proposed canal route are indicated by arrow heads.—ED. THE E.]



THE ISTHMUS OF PANAMA

FAST TRAVELLING IN THE UNITED STATES.

SIR,—I enclose a cutting from the *Atlantic City Daily Press* of November 23rd, showing some fast travelling from Camden—a town on the Delaware Vale opposite Philadelphia—to this City, the information is authentic.

The Reading Railway Company yesterday made the third and last trial trip with engine No. 1028 for the purpose of securing data as to the consumption of water with a heavy train propelled at a high rate of speed. This test was entirely satisfactory, and the run was made under the most favourable circumstances.

As on the two previous days, No. 1028 hauled ten day coaches in addition to the 6000-gallon tender. The same crew piloted the train and the same officials were on board as on Monday and Tuesday. The trip was made from Camden to Atlantic City in fifty-one minutes, or an average of fifty-five seconds per mile. According to the measurements made at the end of the run 5348 gallons were consumed. On the return trip Tuesday afternoon 5400 gallons were used.

The tests made this week prove conclusively that the Reading engines can get over the road between the Delaware and the seashore at the rate of seventy miles and more an hour with ten or more coaches, when one of the big 6000-gallon tanks supply the necessary amount of water, but not with the 4000-gallon tenders.

Some idea of the immense weight of the load and the length of the train pulled by No. 1028 can be obtained when reduced to plain figures. The coaches in the train are extra heavy and weighed eighteen tons each, or a total of 180 tons; they are each 62ft. long, or a total of 620ft. This is the weight and length of the train exclusive of the locomotive and its enormous tender.

The trainmen stated were a test of speed to be made they are confident that No. 1028 could haul this train of ten cars over the Atlantic City Division in thirty-five minutes.

The following facts must be taken into consideration, viz., the line is almost dead level the whole way. The few curves are of an exceedingly large radius. There are no tunnels, the steel rails are extremely heavy, and the steaming power of the huge boilers is enormous.

Atlantic City is America's greatest watering-place, owing to the extraordinary salubrity of the air, and the wonderfully business-like way in which the inhabitants cater for the enjoyment of the public.

The Reading and Pennsylvania lines run almost parallel from Philadelphia, this causing a great rivalry in the train service.

HENRY G. JOY, A.M.I.C.E., of England.
121, St. Charles-place, Atlantic City, N.J.
November 24th.

SINGLE-CRANK COMPOUND ENGINES.

SIR,—In mine of 11th inst., referring to the tandem engine by the Vauxhall Ironworks Company, my remarks as to "strength and wearing surfaces" apply to the valve gear only, and refer to the sentence, "The slide rods, excentrics, and link gear are made especially strong to withstand the strain of working the two valves." One remark of mine is that "strength and wearing surfaces are always advantageous." Will the Vauxhall Company note this?

Noting Messrs. Simpson, Strickland, and Co.'s letter of the 20th inst., I do not claim to have introduced the tandem engine—and I do not care for it, although I make it—but I see that Messrs. Simpson, Strickland, and Co. make this claim, and, I think, without considering. The sentence as to "the slide rod," &c., will apply to Messrs. Simpson, Strickland, and Co.'s tandem, as their slide valves are both in the same steam chest, and under full working pressure, and also the valve spindle gland, therefore wanting more power to work than by the arrangement of the Vauxhall Company's valves and my own. I believe the Simpson, Strickland and Co.'s "modern engines" have still the same valve gear and straight link as in the illustration—no variable expansion.

F. T. HARKER.
Stockton-on-Tees, November 25th.

THE LATE SIR RICHARD MOON.

SIR,—The following story is an illustration of your remarks this week on the late Sir Richard Moon—"He knew his own mind," &c.:—

Many years ago a well-known merchant lived some sixteen miles from the city wherein he carried on business. The North-Western train by which he journeyed home was timed to connect at a suburban junction with another company, whose train was supposed to wait. The other train often did not wait, and the merchant was left behind.

One evening, exasperated at this, he turned back, and went straight to Euston. Next morning he saw Moon, and told his story. Forthwith orders were issued to North-Western officials at a certain junction not to wait for an important express of the other company till matters improved at the suburban junction.

Result: The "other company" ordered the suburban junction station-master to see that Mr. ——— was in the train before despatching.

AN ADMIRER OF THE DECEASED.
November 23th.

OPENINGS FOR MECHANICAL ENGINEERS IN CHINA.

SIR,—Permit me to point out an error which has crept into the paper by Lord Chas. Beresford on the above subject, read before the Institution of Mechanical Engineers, November 24th, and which appears in your current issue. In this paper it is stated that at the time of Lord Beresford's visit to the railway works at Tongshan—so ably controlled by Mr. C. W. Kinder—they were engaged on the first engine ever attempted to be built in China. This is a mistake, as a complete tank locomotive, having cylinders 9½in. diameter by 15in. stroke, was built entirely by native labour at the Kiangnan Arsenal, Shanghai, in the year 1891, to the design and under the supervision of Mr. Thos. Bunt, M.I.M.E., the superintendent engineer of the Arsenal. This was the first locomotive proper ever built in China. An illustration and description of the engine appear in THE ENGINEER, for May 20th, 1898, page 474.

17, St. Ann's-square, Manchester, E. G. CONSTANTINE.
December 4th.

LOCOMOTIVE LIFE-GUARDS.

SIR,—Would some locomotive engineer kindly explain the reason that has led to the placing of railroad engine "life-guards" on the leading bogie truck, rather than on the frame of the engine itself? If we suppose a heavy stone or bar to be on one of the rails, it would appear that its effect on being struck by one of the guards would be to twist the bogie round, and so throw the engine off the line. Were the guard part of the frame itself, the whole weight of the engine would resist the twist, and probably save an accident. Why should a light trolley have upset the express locomotive at Wellingborough?

ALFRED J. ALLEN.
London Institution, E.C., November 28th.

ENGINEERS' MACHINE TOOLS.

A PAPER on engineers' machine tools, with a few criticisms on their general construction was read before the members of the Manchester Association of Engineers at their meeting on 25th Nov., by Mr. A. R. Bellamy, managing director of Messrs. Andrews, Limited, of Stockport, and was followed by an interesting and critical discussion. Mr. Bellamy, in the course of his paper, said he wished to approach the subject simply in the light of a user, who merely considered machine tools as means to an end, and who, he thought, should in all cases receive a guarantee as to the efficiency of the tool from the maker. He then proceeded to criticise the design of various classes of machine tools, at the same time offering suggestions as to points requiring improvement. With regard to the lathe, this was one of the oldest of machine tools, and was therefore one that most people would expect to find made to a standard design, but as a matter of fact, there was a great lack of uniformity in this respect. He thought they should adopt standard methods. In most lathes, the difference was much too great between the last single speed and the first geared speed. With respect to changes of feed all these should be done by means of gears which could be altered by the simple movement of a lever. In most large lathes the slide rest was too high, and did not permit the use of a large section of steel for the tool. It would be of considerable convenience to users if lathe makers would adopt a standard thread for the face plates, and arrange a standard set of sizes and tapers for the loose centres. In planing machines the two-belt drive was much more effective than the single-belt drive. With respect to shaping machines the method of changing the stroke was usually one that caused great waste of time. He thought the change of stroke should be altered at the front of the machine. He had not much to say about drilling machines, except that even the simplest drill should be made to reverse, and that all radial drills should have a proper power motion for raising and lowering the arm, something a little better and quicker than putting on and taking off a belt. In conclusion, he said the worst fault he had to find with most tools was that they were short of power. As a rule, the belt speed was too slow and the gearing too weak. If they took almost any tool and adapted it for the electric drive, where there was no slip of belt, they would find it was only a question of time before the gearing began to give trouble, and ultimately broke down. All large machines that had heavy parts requiring to be moved, should be fitted with a power motion to such parts. Except in a few cases quick hand traverse should be done away with, and quick power traverse substituted. He also found that lubrication in machine tools was, as a rule, very defective. All parts needing lubrication should, where possible, be fitted with proper lubricators, and parts that were difficult to get at should have the oil led to them by pipes coming from one common oil well, as was the case with modern high-speed engines. He might also point out that foundation plans were, as a rule, very incomplete. It was very desirable that every tool should be thoroughly tested before it left the makers' works, not merely put to work, but properly tried with some of the work it would be required to do. As to design, with the exception of milling machines, and a few special tools, most engineers' tools required bringing up to date. In his opinion, their development had been very slow, and defective designs had been too long slavishly copied.

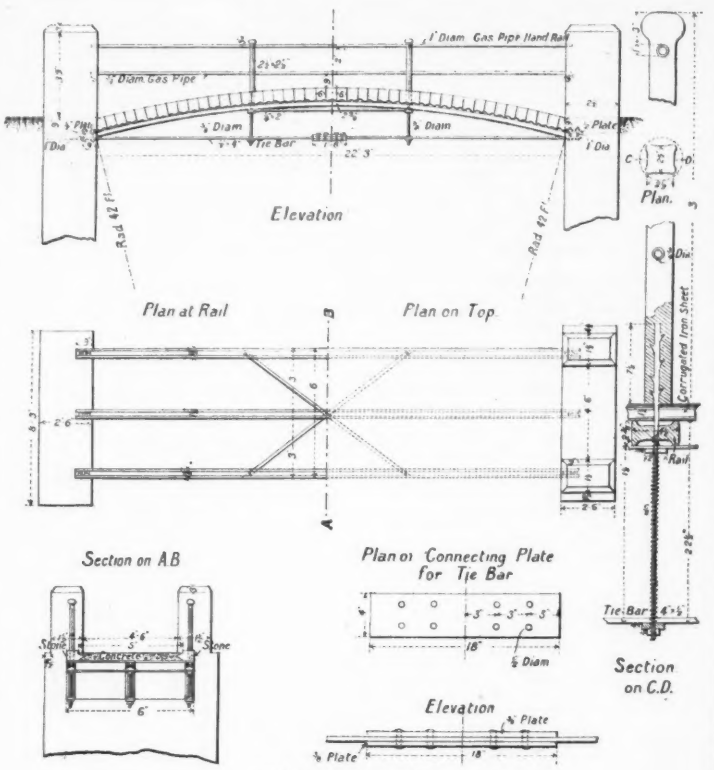
Mr. Alfred Saxon said the difference in speeds, particularly of lathes, from single to double gear, was certainly too great. As to guarantees of efficiency, if they went to a firm who had a good reputation for a certain class of machine, and asked them to specify and quote for one to do a certain amount of work in a certain time, they would generally find it answer satisfactorily. Mr. Joseph Nasmith, who had just returned from a visit to America, observed that if there were any reason for the superiority that was very loudly claimed—in his opinion, far in excess of the merits of the case—for American tools, it lay in the fact that the makers there devoted themselves to the production of only two or three classes of tools, and it was this specialisation that was helping to introduce into this country so large a number of American tools. Mr. S. Dixon said, with regard to efficiency, this was very strictly specified in some of the official specifications—as, for instance, those of the Indian States Railway—and was proved up to the hilt. It was quite common to find two or three inspectors in the works, who had come to see the efficiency tests carried out. In local cases the position was different, because a man wanting a tool generally came to the works and saw what it was doing in the place, and if satisfied would buy it. He would not in such a case want a written paper specification. He had quite expected that the author would refer them to the time lost in setting on machine tools, which was a matter of the greatest importance. He agreed that it was very objectionable to have only one strap on a planing machine. All good modern machines were made for two straps. As to want of power, complaints were often made on this point, where the user was really trying to make the machine do more than it was originally designed to perform. As to makers confining themselves to the production of one or two machines, they would all be very glad if they could arrive at that position; but it was practically impossible in this country.

The conditions attached to most official specifications, which might be for a dozen different machines, did not allow the tool-maker to sub-let any of the work, and he had to take it all or leave it. Then there were certain "fashions" or "runs" in machine tools; at one time it might be planing machines, then screwing machines, milling machines, and so on. Mr. Spencer said his firm had been engaged on some of the close specification work Mr. Dixon had referred to in connection with the Indian States Railway, and other railways in India. As an example of the strength and power required in some of the tools, he might mention that in an axle lathe they had recently turned out the test cut was specified to reduce a 10in. axle to 8in. diameter at one cut with two tools at each end, the four tools cutting at the same time and with a ¼in. feed traverse. English toolmakers were in a position to put any power into machine tools that could be reasonably demanded by users. Mr. E. P. Hetherington said he should not recommend a gap lathe if it could be dispensed with. Many of the ideas toolmakers would like to carry out with a view of improving a tool could be realised if the client would only pay for them.

SOME LARGE ELECTRIC GENERATORS.—The contract for the heavy generating machinery for the new power house and apparatus for the sub-stations, engines, boilers, &c., required for the stationary installation of the Manhattan Railway Company, of New York, has been given to the Westinghouse Electric Company. The apparatus will include eight three-phase alternating-current generators each of 6650-horse power capacity. The external dimensions of these generators will be something over 40ft. square each, while the rotary element, which includes in itself the rotary field of the generator and necessary fly-wheel for the engine, and which will be mounted directly upon the shaft of the engine, will have a diameter of 32ft. It is stated that the weight of each machine and engine complete will be nearly 1000 tons. The current generated by these large machines will be conveyed to various sub-stations placed in different parts of the city, in which will be installed twenty rotary converters in units of 2000-horse power each. These rotary converters will produce direct current at 500 volts for use upon the line. The first of the large dynamos is due for delivery in ten months from date.

CANAL FOOTBRIDGE.

THE accompanying drawings are from the designs of a simple footbridge erected over one of the canals of an irrigation work in India. Ingenuity is as often evidenced in small creations as in more pretentious combinations, and there can be little doubt but that the designs of this small bridge show much ingenuity and simplicity. The design is an economical one, and might prove useful as an example for adoption where suitable, or serve as a suggestion to young engineers called on to design similar structures. It is premised that the work was situated many miles up country in a district where mechanical appliances and skilled labour were not over-abundant. The roadway is supported by three bow-string girders of a versed sine of 18in. and a length of 23ft. 9in. placed 3ft. apart. The bows are improvised of old used-up double-headed rails, obtained from the adjacent Great Indian Peninsular Railway, and bent to the required curve. The strings are formed of 4in. by ½in. bar iron, the sag being taken up by ¾in. stirrups or suspension rods 7ft. 6in. apart. The road platform, formed of tarred corrugated iron sheets laid transversely, is supported by the bows, and on this a road surface of fine concrete is laid. The concrete is retained at the sides by stone kerbs laid voussoir-wise. The roadway is 5ft. wide, and the span of the bridge is 22¾ft. The handrail is formed of two ¾in. gas piping strung through two standards of teak-wood, connected at bottom with the suspension rods. The total cost of the work was only 492 rupees, and the design was by Mr. J. E. Whiting, M. Inst. C.E., who carried out the irrigation project in which the work is included.



WORKMEN'S COMPENSATION CASES.

October 27th.—Manchester County-court. — Plaintiff, Willam Williams; defendant, Thomas Stopford. Judgment was given in this case, which affects the building trade and insurance companies, and which was tried some short time ago. The plaintiff was William Williams, of Moreton-street, Longsight, and he sought an award in respect to personal injuries sustained by him while he was in the employment of Thomas Stopford, mason and contractor, of Royds-street, Stockport-road, Manchester.

His Honour, in giving judgment, said that the respondent urged that he was not the person undertaking the construction of the building, but only a sub-contractor, and therefore was not liable to proceedings under the Act at the instance of the applicant. The facts were these:—By a contract dated the 17th January the Manchester Corporation agreed with Mr. Charles Henry Normanton for the sum of nearly £8000 that he should erect and complete the extensions to the boiler and economiser house in question. With the consent of the Corporation Mr. Normanton was entitled to sub-let portions of the work, and he sub-let the masonry work to the extent of about £500 to the respondent, Stopford. The applicant was employed by the respondent on the masonry work and was injured while standing on a ladder and fixing a window sill. The question for decision was whether the respondent was an undertaker within the meaning of Section 7 of the Workmen's Compensation Act. This was an important question, and owing to the way in which the Act is drafted it had been left in some obscurity, but he thought that the probable intention of the Legislature was not to make sub-contractors liable under the Act. In this case it was admitted that the applicant was within Section 1 of the Act. This was an employment to which the Act applies, and was a personal injury arising out of and in the course of the employment, and subject to Section 7 the present respondent would be responsible under the Act. Section 7, however, says that "the Act shall only apply to employment by the undertaker, as hereinafter defined." Now the word undertaker in the case of a railway or a mine has a special meaning, but in the case of a building all we are told is that undertaker means the persons undertaking, which is only an embarrassing way of saying that the word undertakers means undertakers. We are therefore driven to the general policy of the Act to explain the meaning. He understood it to be an insurance Act, and therefore it seemed sensible to give the applicant a remedy against one person who was responsible for the whole building which he undertook to build, and he thought that this was intended by the Legislature. In the case of a railway company sub-contracting with carriers whose men assisted in the unloading of trucks and where one of the men was injured, say by a shunting accident, there would clearly be no remedy under the Act against the actual employer, the carrier, but only against the railway company. Section 4 of the Act was read by counsel on both sides as assisting them. In his view by Section 4 the applicant would be without any remedy under this Act. Section 4 gave him a remedy against Normanton, the undertaker, and gave Normanton in certain cases a right to indemnity against such contractor. The words at the end of the first paragraph of Section 4, "would be so payable if such contractor were an employer to whom this Act applies," meant if such contractor were an undertaker. Of course, Section 4 made an undertaker liable for the personal neglect and wilful default of his sub-contractor, but that was a matter wholly outside the present case except in so far as it pointed to a desire of the Legislature to make him the person primarily responsible to all the workmen employed on his work. Some little point was made of the use of "persons" and not "person" in the undertakers definition clause. In his view that could only be meant to cover the case of a separate letting of contracts by a building owner to separate contractors. There all the contractors would be in his view undertakers. He should therefore say in all cases that the undertaker in the case of a building meant the direct contractor with the building owner and not any sub-contractors entrusted with a portion of the work. If it were otherwise a sub-contractor might be saddled with compensation to be paid to his workmen from an accident caused by something or somebody wholly out of his control, and would have no immediate right of indemnity whatever. He could not but think that, if the Legislature had intended the undertaker and the sub-contractor to have been both primarily liable to the workmen, the Act would have dealt with the indemnification of sub-contractors by undertakers just as it does with the indemnification of undertakers by sub-contractors. He had given judgment at unusual length in this case, because he understood it is desired to appeal, and as the question was one of grave importance to persons engaged in the building trade, and incidentally to insurance companies, he hoped that appeal might take place, and he wished to facilitate it in every way. The result of this is that no award is made.

Plaintiff's counsel hoped that it might be a case for costs on the increased scale, and that it would go higher.

Defendant's counsel said he did not think the case would be taken higher by the workman. He was unsupported, and it would be impossible to take it higher.

His Honour said he regretted to hear that, as he had hoped to have the point settled.

Plaintiff's counsel said that in these circumstances he did not press for increased costs.

His honour said he thought costs should be on the increased scale, not to be taxed unless further proceedings were taken.

November 8th.—Salford County-court.—Plaintiff, R. E. Cheltnam; defendants, the Manchester Ship Canal Company. The applicant was a crane boy in the employ of the Manchester Ship Canal Company. A certain time was allowed the applicant for meals, and on the 7th March, whilst leaving the place where he worked during meal-time to go away from the company's premises, but whilst he was still on the premises, he caught his foot in some points, and the result was that he was run over by an engine belonging to the Ship Canal Company. The respondents contended that the youth was not injured whilst in their employ, and further that he had not made his claim in the required time. The Judge expressed surprise at this, and said that a claim for compensation, whether verbal or in writing, which brought home to the respondents the fact that compensation was claimed was sufficient. The Act did not make it necessary that the claim should be in writing. A claim was made by the applicant's solicitor on July 20th, within six months of the accident. He thought that the Act applied to a man from the moment he enters the premises until the time he left, and also, so long as he was moving about the premises for a proper purpose. The case, in his opinion, came within the meaning of the Act, and the applicant must therefore be allowed permanent relief, and the costs would be made on the B scale. A discussion ensued, and it was eventually decided to pay the applicant 5s. 8d. a week.

November 8th.—Salford County-court.—Plaintiff, George Lysens; defendants, Andrew, Knowles and Sons, Limited. The defendants submitted that they were not liable, seeing that the man had only worked two days. His Honour, in giving judgment, said that on the 20th July, 1899, the man was injured by a fall of coal. He commenced to work on Tuesday, the 18th, at the rate of 6s. a day. The applicant was, in fact, a piece worker. The case was an important one, the respondents contending that he was not entitled to any compensation under the Act. In the first place, if a servant was employed on a weekly wage the position seemed clear. When he was injured he was unable to continue his work owing to involuntary illness, but he continued in his master's employment, and unless his master terminated his contract he was bound to pay him wages. The illness or the accident did not end the contract, and the weekly wages became due. When the master terminated the contract it was perfectly easy to calculate the average weekly earning for any less period than a year during which he had been in the employment of the same employer. There seemed to him to be little difficulty in the position of a weekly earner, but the position in the case now before the Court was that of a piece worker. It was of no consequence whatever for the purpose of the Act when the respondents made up their books. All that he—his Honour—had to do was to find the number of actual weeks worked, and the actual amount of money earned by the piece worker. He held that the applicant had worked one week, and earned 12s., and he was therefore entitled to 50 per cent. of his average weekly earnings, and he awarded judgment to the plaintiff with costs. His Honour added that he hoped the case might be carried to the Appeal Court.

November 13th.—Mountain Ash County-court.—Plaintiff, Henry Haines; defendants, the Penrhiwceiber Colliery. The claim was made by Henry Haines, a haulier, employed at the Penrhiwceiber Colliery, for compensation alleged to be due as a result of an accident received while following his employment. He was in charge of a tram of coal, which became derailed. In trying to replace it he ruptured himself, and was incapacitated from proceeding with his work. He was subsequently sent to the Cardiff Infirmary, where an operation was performed upon him. In the performance of this operation it was discovered that he had been ruptured on a previous occasion, and the medical men who made the discovery gave it as their opinion that the strain in attempting to lift the tram would probably not have resulted in a second rupture but for the existence of the first. Upon this testimony the respondents denied liability to pay compensation, on the ground that the second rupture was not the original or primary cause of the injury. His Honour, in delivering judgment, said it was necessary to define the meaning of the word "accident," within the meaning of the Act. He thought that, broadly, it could be defined as "every case of personal injury, however caused, which arises in the course of employment when not attributable to serious and wilful personal misconduct." Then, in order to apply that definition in this case, it appeared to him—the judge—that the defendants, in order to sustain their contention, should convince him that a man, while suffering from a disease, exerted himself to such a degree as to aggravate or accentuate the disease, and thereby was guilty of serious and wilful misconduct. It was necessary to cite one case only in order to indicate the fallacy of the respondent's contention. That was the case of Isite *v.* Railway Passengers' Assurance, where it was laid down in effect that a man suffering from disease prior to the injury would be entitled to compensation if the disease or injury had been accentuated by the accident. He therefore awarded the compensation claimed by the applicant, with costs on Scale B. The defendant's counsel applied for a stay of execution, as in all probability an appeal would be made. His Honour said it was very hard that this man should be kept without any means of maintaining himself, and suggested that the respondents should pay the amount weekly pending an appeal.

November 18th.—Court of Appeal.—Plaintiff, Williams; defendants, Poulson.—This was an appeal from an award of a judge of the Liverpool County-court, in an arbitration under the Workmen's Compensation Act, 1897, and raised an important question of general interest as to the way in which weekly compensation was to be calculated when the injured man had been less than one week in the master's employ.

The admitted facts were that the workman was a stevedore, and at the time he met with the accident was working for the defendant assisting to unload cargo from a vessel in the docks. During the twelve months preceding the day of the accident he had worked on and off for the defendant on various occasions. He had, however, only been engaged for three and a-half days on this particular job when the accident occurred. The learned County-court judge had calculated the amount of the earnings during the preceding twelve months earned by the plaintiff from work done by him for the defendant. This amounted to £38 13s. 6d., and 50 per cent. of the average weekly earning of the plaintiff on this basis came out at 7s. 6d. Williams gave evidence that he earned 5s. a day, and that his earnings averaged 28s. a week throughout the year, and he claimed compensation at the rate of 14s. a week. The question whether the workmen in such a case as this depended on the construction to be placed on the first schedule to the Act which regulates the amount of compensation to be given, first, in the case of death resulting from the accident; and secondly, where total or partial incapacity for work results from the injury. The section says "that in that case a weekly payment during the incapacity after the second week not exceeding 50 per cent. of his average weekly earnings during the previous twelve months, if he has been so long employed, but if not, then for any less period during which he has been in the employment of the same employer, such weekly payments not to exceed £1."

The Court was invited to construe this section of the schedule as meaning that the average weekly earnings was to be arrived at by six times the daily wage of the workman or his average weekly earnings throughout the year. In fact, assessed on his average earnings as a labourer on the market.

LORD JUSTICE A. L. SMITH thought that as the workman had not been engaged to unload this ship for a week before the accident happened, and there was no evidence that he was engaged at any time by the week, the section was not applicable to this case at all.

Counsel said he appreciated the difficulty, but there was no question that the man was entitled to claim compensation under the Act, and if men who were paid by the job or by the piece were to be excluded, half those workmen which the Act was clearly intended to cover would fall without it.

LORD JUSTICE A. L. SMITH said he saw great difficulty in the matter. This was a fresh contract, and it had only lasted three and a-half days; and was the limitation "then for any less period—than twelve months—during which the workman had been in the employment of the same employer," to be held as cutting down the employers' liability in such a case as this to 50 per cent. of the weekly average on the basis of the actual three and a-half days' earnings?

Counsel pointed out that the amount of compensation would be very small indeed, and if the accident had happened on the first day he had been engaged, infinitesimal, for it would practically be a weekly allowance of a 100th part of the few shillings he had earned. He thought that this *reductio ad absurdum* showed that the weekly earnings of the injured man must be found by the arbitrator as six times the rate of the day's pay. He suggested that a reasonable construction to put on the words would be to take the average that the workman earned in the twelve months previous—his weekly value as a workman in the labour market.

LORD JUSTICE A. L. SMITH asked if, in the interests of his client, counsel would withdraw the appeal and rest content with the 7s. 6d. a week compensation awarded in the Court below.

Counsel replied that those who were behind his client desired to carry this matter as far as they could, in order to have this important question decided.

LORD JUSTICE A. L. SMITH said in his judgment the appeal should be dismissed. It was found as a fact by the learned judge that this workman had been working for a period of twelve months, off and on, for the same employer for whom he was working when he met with the accident. It has been held in a previous case by that Court arising under the same section, that a workman, in order to recover compensation, must have been for the period mentioned in the employment of the same employer. The learned County-court judge had, however, here found that the contract of service had not been broken, and had treated it as existing continuously during the year previous to the accident. He also found that the injured man had during that period received from the master the sum of £38 odd. To contend on those findings of fact that the County-court judge was wrong in awarding 7s. 6d. a week appeared to him to be beyond argument. The master did not desire to raise the point whether this workman was entitled to any compensation. Had he taken that point in the Court below, a very difficult question would have been raised. But he had not done so, and without deciding whether or no this workman was entitled to recover compensation at all under the Act as it stood, he must hold that the workman was entitled to compensation in this case, and that the award had been rightly calculated by the County-court judge. The appeal therefore failed. The other Lords Justices expressed views concurring with those expressed by Lord Justice A. L. Smith as to the effect of the findings of fact found by the Court below. The workman's appeal to vary the award was accordingly dismissed.

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S., President, delivered on November 16th, 1899.

THE Institution of Electrical Engineers represents not only a great and growing industry, but also an important scientific profession. Any man, therefore, who finds himself placed by the will of his fellow-members in the position of president of such an Institution may well ask himself on entering upon his term of office as head of the profession, what are the interests of the Institution, what the most pressing needs for its development, and how he can best serve those interests or aid in that development.

In these days the advancement of science depends largely upon the mutual co-operation of scientific workers and of the societies founded for the diffusion and co-ordination of knowledge. The progress of electrical engineering, both in its industrial and its professional aspects, depends likewise in no small degree upon the combination of electrical engineers of all classes in active union. Rightly conducted, the influence of such an Institution as ours, both within and without its borders, is very great. If we speak in the name of the united profession, with the weight of the whole industry to emphasise our views, we command the respect, not only of all other professional bodies, not only of other industries akin to ours, but of public bodies, central as well as local. We can influence even the administrative departments of the Government itself when considering any regulation or proposed legislation touching electrical questions.

Further, our discussions in this room have a most direct influence not only on the development of electrical practice, but on that of electrical science. To find an instance I need hardly go further than the presidential address of Professor Hughes in 1886, which set the electrical world discussing the effects of self-induction. The number of scientific papers read before this and other bodies during the succeeding two or three years upon the measurement of self and mutual induction is directly attributable to the effect of that remarkable address. In the electrical world, however, there are many other influences at work. Great as may be the influence of scientific societies, of the open discussion of scientific and technical problems, there are others equally potent. The prices of the materials used in our industry—iron, steel, copper, gutta-percha, india-rubber, mica—the cost of coal, the cost of water-power, the cost of transport by land and sea, the cost of labour, the technical skill and training of our designers and manufacturers relatively to those of our foreign competitors—all have the most direct influence in determining the development of the industry in one direction or another. At a time of disquietude in international politics many of these factors in the problem may far outweigh the direct influence of our Institution. All of them will have an influence direct or indirect on us. For we flourish in proportion as the electrical industry flourishes; and as the Empire flourishes, so will our Institution share in the general weal. Yet amid this complicated state of the conditions which determine the future of the electrical industry, our Institution can render real and lasting service, if by directing attention to the things which make for progress, if only by pointing out the path along which technical advances are being made or are to be made, it can assist the manufacturer, the designer, the contractor, the consulting engineer, and the capitalist, and ultimately the authorities of local and central government. There is no question but that at the present time money is being spent in this country, in many directions not to the best advantage, on electrical schemes which are ill-advised, or antiquated, or too petty; that machinery is being constructed on wrong lines, to be discarded a few years hence long before its natural term of life is reached; that electrical appliances, because not made to the standards recommended by experience, are made in smaller quantities at a time and therefore at greater expense than need be. Our Institution, by the recommendations of its Standardising Committee, has tried to prevent at least some of this waste; and it might do much more without imposing any harmful restrictions upon the freedom of a single individual. If it can point out the trend of opinion, the ameliorations resulting from experience in all parts of the world; if it can help to diffuse amongst its membership generally a knowledge of these things and of the latest discoveries and inventions, the benefit it will confer not only on its members, but on the industry at large, will be no small one.

I therefore propose to direct your attention to some of the tendencies which manifest themselves at present in the electrical world; some of them, doubtless, transitory, but others indicating changes of a permanent kind.

In telegraphy, the oldest branch of our profession, there is not much room to chronicle change. Nevertheless there is an obvious tendency to increased use of automatic methods of sending. Slowly but surely the use of the automatic transmitter is extending in cable service; whilst on the Continent and in America the advantages of the Wheatstone automatic are being gradually recognised, as the increase of matter to be transmitted over existing land lines causes a demand for accelerated methods. It may be here recalled that the very first paper read before this Institution on March 13th, 1872, when it commenced operations as the Society of Telegraph Engineers, was on the topic of "Automatic Transmission." The use of alternating currents of a fairly high frequency is also receiving attention. Professor Rowland has invented a multiplex typewriter working with alternate currents. The substitution of delicate optical receivers, working by photography for the purpose of enabling more rapid signals to be received, for the relays and recorders previously used, opens out a further field. Just as the limit at which the hand can send is surpassed by the automatic sender, so the speed at which the eye can read the visible motion is surpassed by that of the photographic receiver. In this connection the recent suggestion on the one hand of Squier and Crehore, and on the other of Pollak and Virág, demand careful attention. The experiments of the latter between Buda Pesth and Berlin appear to have come as a surprise to many continental electricians not previously conversant with the Wheatstone automatic transmitter; while the success that they have obtained in sending words at the rate of 1300 to 1500 words per minute over a land line 475 miles long once more raises the familiar question whether a mile or two of subterranean cable inserted in the line would not have effectually barred the transmission and reduced it to ordinary rates. We need not believe all the nonsense telegraphed by special correspondents to the daily Press from Vienna, that home of scientific canards. But Pollak and Virág's results are of more substance than the imaginary achievements of Jan Szczepanik. It is interesting to note that in their experiments success was largely due to the use at each end of the line of an inductive shunt—a device advocated so strongly for cables by our late past-president, Mr. Willoughby Smith.

When we turn to the question whether such rapid methods of signalling will prove of any use on subterranean or submarine cables, we are still confronted by the old difficulty that no improvements whatever in apparatus at the ends of the cable will get rid of the sluggishness inherent in the cable itself, if constructed upon the traditional patterns. The suggestion which I advocated in 1893, of accelerating the speed of signalling by attacking the problem in the middle, instead of tinkering at the ends, has not yet borne fruit. My suggestion to construct cables with a series of self-inductive artificial leaks of high resistance distributed all along its length, to combat its distributive capacity, appears to be too radical to be acceptable to the cable authorities. But it is self-evident that whatever good an inductive shunt—or artificial "leak"—at the end of a cable will do in getting rid of the static charges, an inductive shunt—or artificial inductive "leak"—at the middle will do just twice as much. Why, then, should the suggestion to utilise this known property at one or more points along the length of the cable not be put to an experimental trial?

Of the tendencies in the telephonic world I forbear to speak. Great Britain has little reason to be proud of her record, past and present, in that line. She allowed the microphone, freely given to the world by its too generous inventor, to be exploited as a monopoly by others.

The competition of electricity with gas as a means of illumination has been rendered very severe by the improvements introduced during recent years in incandescent gas lighting. The discovery of the properties of the rare earths in giving an augmented illumination—the result of a purely scientific research—was the foundation of the invention of the Welsbach mantle. It is singular that the very same properties were not turned to account in electric illumination before the invention by Nernst of the lamp which bears his name—a lamp for the commercial introduction of which electrical engineers are still waiting expectantly. Meantime, a far more important factor in the economic struggle remains in a possible reduction of the high prime cost of electric wiring of buildings. Could electric house wiring be carried out as simply and as cheaply as the putting in of gas pipes, an enormous advance might be confidently expected. But so long as our station engineers and our fire insurance inspectors insist on having both wires fully insulated, and do not allow an uninsulated or a semi-insulated return conductor, so long will this advance be delayed. With the introduction of armoured conduits for interior wiring, surely the prejudice which requires a double insulation will disappear.

In the public distribution of electric energy for lighting and power the necessities of economic working are effecting a slow but sure revolution. The methods that were in vogue at the date when the Electric Lighting Act of 1888 made electric distribution in this country commercially possible are being superseded. Larger generating units are being used in our stations. Larger areas of supply and fewer generating centres in an area are a necessity of the time. From the row of little bipolar dynamos, each with its own small high-speed engine—a sight so familiar in the older lighting-stations of this country—we are gradually passing to the use of large multipolar machines coupled to larger and more economical steam engines. Ten years ago, a distribution at six miles from the generating station was looked upon askance by many electrical engineers. To-day it is recognised that the secret of economical work is to generate on the large scale—"in bulk," as the phrase goes—and to distribute over large areas at an appropriately high voltage. Whether the prime source of power be hydraulic or thermal, the problems of economic distribution are essentially identical. Two of the most recent examples—both of water-power stations—must suffice. At the Kanderwerke at Spiez a pressure of 4000 volts suffices for the distribution of current for lighting and power within a radius of six miles; but for the thirty-mile distribution from the same station to supply the city of Berne and the Burgdorf-Thun Railway a 16,000 volt pressure is adopted. The city of Milan, which is lit by power from the hydraulic station at Paderno, twenty-four miles distant, receives its currents at 13,500 volts. When electric energy is thus generated and distributed on the larger scale the time-honoured methods suitable for parochial areas must give way to newer ones of greater economy. Continuous-current generators and motors are unsuitable for operation in such wise at economic voltages. The great superiority of alternating currents asserts itself here uncontested. And with the greater economy of copper that is afforded—in the transmission at a given superior limit of voltage—by the use of three-phase currents, commercial considerations of the most elementary order decree that the fittest shall survive. It was, doubtless, in its time a great advance when the late Dr. Hopkinson in this country, and independently Mr. Edison in America, introduced the "three-wire" system, in which by the employment of a central or neutral wire three copper conductors were made to suffice where four conductors had previously been needed. The obvious economy of using one neutral wire instead of two separate return conductors was sufficient to secure its rapid adoption. But with the introduction of the three-phase distribution we may now have three wires doing the work of six, each wire, when the circuits are equally loaded, serving as a return for the currents of the other two. In cases where, as in three-phase lighting, the three lines are not equally loaded, we may, by adopting a Y grouping with a neutral wire leading back to the common junction, have one neutral wire serving in the place of three separate return conductors; thus carrying forward Dr. Hopkinson's idea to its logical extension. Experience in Heilbronn, in Strassburg, in Lyons, and a score of other places, proves that the fear formerly expressed as to difficulties in balancing the circuits is unfounded. In the light of such experience it is not premature to say that the use of the three-wire system with continuous currents is obsolete. Obsolete it is not, however, in the sense of being disused. Obsolete it is, in the sense that a better and more economical method is known and is already largely in use. Of all the new lighting stations now under construction in middle Europe, quite two-thirds are designed for three-phase work. Even in Berlin, where the admirably engineered group of lighting stations on the continuous-current plan has been eminently successful, financially and technically, all extensions are being made on the three-phase plan; and in a few years the whole will probably have been converted to alternating currents.

While the continuous current is, of course, the only species admissible for electrolytic work with all its rapidly growing applications in the chemical industries, the superiority of alternating currents for motive power and for all long-distance work is every day becoming apparent. Only a very short time ago it was the fashion to decry alternating currents on the alleged ground that alternating-current motors were not self-starting. That reflection might have had some weight ten years ago. But the simple truth is that continuous currents will not work motors at all except toys of the old Barlow wheel type. Let him who doubts this statement ask himself what is the purpose of that costly organ, the commutator, which is an integral part of every so-called continuous-current motor. The sole function of a commutator is to commute a continuous current into an alternating one, or *vice versâ*. If a continuous current will drive a motor, why go to the expense of putting into any motor a commutator to commute that current into an alternating one inside the machine? Moreover, the unnecessary commutator—for it is unnecessary if the currents are supplied to begin with as alternating currents—introduces the risks attendant upon the use of "brushes"—risks which have led the insurance companies to prescribe that all motors with commutators should be put in fire-proof enclosures. Let it be once realised that the commutator is an unnecessary excrescence due to the supply of a particular kind of current which won't work a motor until commuted, and that, with the supply of the proper kind of current, no commutator is needed, and before long we shall see these restrictions withdrawn. A common grindstone is a thousand times more likely than a well-constructed modern commutatorless motor to cause an outbreak of fire. Yet no one prescribes fire-proof enclosures around grindstones in any ordinary factory.

Another tendency of the times is the simplification of the switchboard, its construction of fire-proof materials throughout, and with more room both before and behind for the good arrangement of gear and connections, and the avoidance of an unnecessary multiplication of fuses. The avoidance of step-up transformers by direct generation at high voltage is in itself an obvious step towards simplification.

In the working of alternate-current generating stations, where parallel running of a number of generators is a necessity, the station engineer has always had before him the fear of a serious breakdown, should anything happen to one of the generators. If the field magnet of any one generator loses its magnetism through any failure of the exciting current, then all the other generators instantly pour an immense current through its armature, with dire disaster, not only to it, but to the station as a whole. All manner of devices have been designed to combat this dread eventuality. Fuses and safety devices of every description, including automatic disconnecting gear warranted only to operate for currents in opposition of phase, are found not always to do their duty. Much discussion has arisen as to whether the excitation of alternators in parallel ought to be an excitation in parallel, or whether each alternator ought to be provided with a separate exciter on its own shaft. Even excitation in duplicate from two independent sources has been tried. It is satisfactory to note that a means has been discovered which will entirely remove this source of anxiety, and render such accidents impossible in the future. Let me here narrate a test described in a recent number of the *Bulletin de la Société Internationale des Electriciens*, December, 1898, page 498, upon two alternators of 250 kilowatts each, direct-driven at sixty-seven revolutions per minute by two horizontal compound engines, the alternators being constructed by the well-known house of Farcot. Both alternators were separately excited, and were synchronised together, and put in parallel in the usual manner. While thus running, the excitation was suddenly cut off from the field magnets of one alternator, and then the steam was cut off from the engine of the other alternator, which remained excited. Both machines continued to turn, the unexcited alternator continuing the supply, furnishing current for the lighting circuit, and also supplying enough current to continue to drive at nearly normal speed the other machine and its engine. This extraordinary test, repeated many times, took place in the lighting station of the town of St. Ouen. The explanation lies in the construction of the alternators. Their revolving field magnets are furnished, on the plan suggested by M. Leblanc, with the device termed by him an *amortisseur*, which is nothing less than a simple and substantial squirrel cage of copper embedded in the pole pieces of the field magnets, each pole being perforated with six slots to receive six stout copper rods, the whole of which are short-circuited together by two external rings of copper. We are all familiar with the device of the embedded squirrel-cage construction introduced by Dobrowolsky and Brown, nearly ten years ago, into the so-called *rotors* of polyphase motors. In these motors the squirrel-cage structure revolves at a slightly lower speed than that of the revolving magnetic field; and it has long been known that if the same structure is mechanically caused to revolve at a speed slightly above synchronism, the machine becomes a generator, taking power to drive it. In brief, the induced eddy-currents in the copper structure, when revolved above or below synchronism, magnetise it and make it work as a field magnet. Leblanc, adapting this device to the actual field magnets of alternators, has not only simplified the operation of synchronising, but has given to the alternator the new and remarkable property that, on the failure of the excitation from the ordinary source, the automatic action of the eddy-currents comes into play, and thereby entirely prevent the disastrous reactions which have been so much dreaded by station engineers. I regard this invention as one of the most important of recent years. It has been applied also to the 600-kilowatt alternators in the sector of the Champs Elysées in Paris.

Passing from the generation of current to its utilisation for electric traction, the most notable evolution now in progress is that of the application of electric power to heavy railways. The application to street railroads—in other words, to mere tramways—has been an accomplished fact for ten years on the other side of the Atlantic, where there are now thousands of miles of electric tramways, mostly operated from overhead lines from which the current is taken by a contact trolley-wheel. If in this country the development of electric tramways has been slower, we have at least the advantage that our cities are not disfigured by networks of overhead trolley lines. No such objections hold good for rural districts, and slowly but surely both the industrial and agricultural distrits of England are being furnished with electric intercommunication with its many attendant advantages. It may come as a surprise to many who think England behindhand in this respect, when they learn that while the total subscribed capital invested in this country in 1899 for public electric supply is £17,800,000, no less than £20,800,000 is already invested in electric traction. Of the effect of the introduction of electric traction as a social and economic factor I have spoken elsewhere, There can be no question of the immense social benefit, particularly to the artisan population, afforded by this means. But the electrical engineer is now engaged on the still greater problem of operating heavy railways, and the development in this branch is being watched with keen interest. The two deep-level railways in London, the City and South London Railway and the Waterloo and City Railway, both of which have amply justified their promoters, are shortly to be supplemented by the Central Electric Railway, an undertaking of much greater magnitude, while several other similar schemes are either under construction or authorised. In the City and South London Railway the rolling stock is designed for separate electric locomotives, each drawing three passenger cars. The gauge is 4ft. 8½in. On the Waterloo and City line the trains consist each of four cars, of which the two end ones are fitted with motors, four motors on each terminal car, so that the train can be driven by either set of the four motors. Each train can carry 204 passengers. The gauge is 4ft. 8½in., but owing to the size of the tunnel ordinary railway rolling stock could not be used. In the Central London line the gauge is also 4ft. 8½in. The locomotives, each with four gearless motors, weigh thirty-five tons each. Each will draw a train of seven cars, with a seating capacity of 336 persons per train. The total length, including sidings and cross-over lines, exceeds eight miles of double track.

In all three of these railways the current is taken from a third rail on the surface, and the return circuit is through the ordinary rails, which for this purpose are bonded with copper bonds. All these lines are operated by continuous currents at 400 to 500 volts. In the case of the Central London line, part of the feeding is effected through rotary converters which receive three-phase currents from step-down transformers.

In sharp contrast to these three London undertakings is the Burgdorf-Thun Railway in Switzerland, which was opened in July last. It is in every sense of the word a full-gauge railway. Not only is its rolling stock full gauge—the full gauge of Switzerland is 4ft. 8½in.—but the railway admits of use by ordinary steam locomotives, drawing ordinary trains. The electric rolling stock is of two kinds—automobile cars carrying sixty-six passengers each, for use singly or in pairs, and locomotives of 300-horse power each, for drawing trains of ordinary carriages or goods wagons. This railway is worked by alternating currents supplied in three phases, at 750 volts, the feeding being effected through stationary transformers at 16,000 volts. The currents are taken from two overhead conducting wires, the rails serving as the third conductor. The length of line thus electrically equipped is 40 kilom., or twenty-six miles. The arrangements were designed, and the electrical equipment constructed, by Brown, Boveri, and Co., of Baden, who were the first to apply three-phase currents to traction. In the Lugano tramways as a commencement, then in the steep mountain light railways of Engelberg, of the Cornergrat, and lastly of the Jungfrau, they gained experience in this method, which now stands triumphantly demonstrated in its adaptability to the service of heavy lines. In the United States heavy railways have been to a very limited extent operated by electric locomotives. Some built for the Baltimore and Ohio Railroad, weighing about 90 tons, are employed to draw ordinary trains over a short line around part of the city of Baltimore. They work with continuous currents from overhead trolley lines.

There can be little doubt, however, that to Switzerland rather than to America we must look when desiring guidance as to the future development of this problem. All necessary data now exist for the exact working out of the necessary equipment of any given line, actual or projected. No experiments are needed to enable the constructor to proceed, so soon as it shall have been determined which kind of current is to be used. Already it has been found in the designing of the Central London line that continuous-current methods, however suitable for light and short railways, and for tramways where frequent stoppages occur, fail when the current has to be supplied from a distance of several miles, alternating currents being brought in because of their greater economy in transmission. The extraordinary thing is that this having been so far grasped, the whole of the rest of the equipment was not designed to match with three-phase motors, instead of introducing the complication of rotary converters to

work continuous-current motors. Time alone can show how the mixed system adopted will work in practice. To me the choice of the mixed system appears of doubtful wisdom. Perhaps the distinguished engineers who are understood to be spending £30,000 on experiments for the Metropolitan Railway to enable them to recommend the best system for our inner circle underground line, will shortly be able to report whether a simple three-phase system throughout is, or is not, more economical than either a continuous-current system throughout, or than a mixed system with converters. If they do not settle this question, which is to-day the one important question in electric railway work not yet settled, we must regard the expenditure as pure waste.

(*To be continued.*)

NOTES FROM JAPAN.

(*By Our Special Correspondent.*)

The Formosan Railway Company.—This was originally taken up as a private speculation, but liberally backed up by the Formosan Department of the Japanese Government, conditionally upon certain engagements being carried out. Although the periods named for the fulfilment of these conditions were extended more than once, the original promoters found themselves entirely unable to carry out their programme, and for various reasons capitalists were not sufficiently convinced of the soundness of the investment to come forward with sufficient liberality. Various reports—some of them based upon contracts which were absolutely drawn up and shown, in confidence, to divers individuals, but which proved, upon examination, to represent what the promoters wished, but had not been able to obtain—were industriously spread abroad, one of them being that a certain well-known firm, whose business is to build locomotives, and not to find capital, were prepared to finance the whole scheme to a fabulous extent; but the result has been that the company was ultimately very glad to relinquish its concessions, and to transfer the whole scheme to the Formosan Government upon very favourable terms, sufficient to recoup it for any actual outlay represented by actual results. The balance-sheet, which with Japanese accuracy is given to the thousandth part of a yen—say, the tenth of a farthing—was published a few days since, and, omitting fractions of a yen, stands as follows:—

RECEIPTS.	Yen.
Starting fund of the promoters, at 50 yen per capita ..	12,550
Security against subscribed shares, at 2½ yen per share	388,712
Interest on deposits and other income	24,791
Buildings sold	1,000
Interest on deposits not yet received	3,258
Estimated income from sale of telephone and other equipments	471
Rolling stock and railway route charters transferred to Formosan Government	294,045
Total	724,827

EXPENDITURE.	Yen.
Starting expenses	26,400
Rolling stock and survey of routes	294,044
Security against subscribed shares refunded	388,713
Starting fund returned	12,550
Expenses incidental to dissolution	550
Expenses incidental to liquidation	2,569
Total	724,827

It is, of course, a necessity for the Government to open up the country, and make adequate provision for the transport of troops; and if they cannot find any responsible private company to do it for them, they must do it for themselves, even if it means the postponement of one or two pet railway schemes at home.

The Hokkaido Railway Company has just declared a dividend at the rate of 12½ per cent. per annum. Although the profits on its coal business have slightly decreased, the diminution has been more than compensated by the earnings of the railway.

Street traffic.—According to the returns of the Osaka Chamber of Commerce, the increase in the number of jinrickshas for hire does not keep pace with the increase of the population, nor in comparison with the years previous to 1896, as will be shown by the following table:—

	Single.	Double.
June, 1896	11,432 ..	2,052
December, 1896	11,648 ..	2,070
June, 1897	12,366 ..	2,060
December, 1897	12,187 ..	2,082
June, 1898	12,222 ..	2,142
December, 1898..	12,508 ..	2,110

At the date of the last return—December 31st, 1898—there were 2442 establishments where jinrickshas were hired out to pullers, who as a rule, do not own their vehicles, and 12,868 jinricksha men. The comparative decrease is attributed to the increasing use of telephones and of bicycles. Owing to the narrowness of most of the streets, tramcars are inadmissible, and the traffic by omnibuses is a negligible quantity.

As regards the Tokyo tramways, the three rival schemes to which I alluded in a former letter have now been amalgamated into one, but their promoters are now confronted by a strong opposition, who contend that a lucrative undertaking of this description ought to be retained in the hands of the corporation. As the Diet has not yet assembled, it is impossible to say what Bills will be presented on the subject; but as several fairly well-known politicians, and a good many of the smaller fry, are interested—one might almost say retained—on both sides, the rivalry bids fair to become a party question. During this clash of interests, the Serpollet scheme appears to have been somewhat overlooked, and no public street trials have yet been made, although the engine, which has been on private exhibition, is of the same gauge as that of the Tokyo Tramway Company. For continuous use, it is probably rather too heavy for the light tram rails at present laid; but the reason alleged by the promoters for not applying for permission to run it experimentally on the existing lines, with the idea of showing that it would be cheaper for them to adopt it than to continue to employ the miserable horses at present in use, is, that owing to the slow speed of the existing traffic, which could not, of course, be put on one side, the Serpollet car would have no opportunity of showing its superior capabilities, or its economy per passenger mile—to adopt a new phrase—compared with horses. At present it seems as if it would take us as long to get an adequate tramway service as it has done to get a sufficient water supply, which as yet is only available over an extremely limited area.

The first Korean railway.—Japanese and Korean affairs have always been so intimately connected that a short account of the recent opening of the railway from Söul to Chemulpo, to be known in future as the Kyeng-in Railway, will not be entirely out of place in these notes. This railway was originated by Mr. Morse, of the American Trading Company, Japan, but was taken up by the Japanese Government, who appropriated yen 1,800,000 to the enterprise. The total length will be 26¼ miles, but at present the line is only open from Chemulpo to No-dol, about 5 miles short of Söul, as the Han bridge, a structure over half a mile long, is not expected to be completed until June, 1900. The materials for the permanant way, and the rolling stock, have been obtained from America, and the line is to the standard American gauge. The opening festivities were held at Chemulpo, but the first trip was from Chemulpo to No-dol, where the distinguished guests were to be picked up. Mr. Hayashi, the Japanese minister to Korea, and most of the Korean ministers and other Korean invited guests, were there in time; but the other foreign ministers and foreign guests failed to turn up, owing to some misunderstanding as to time. After waiting much more than a reasonable period for them, the return journey was commenced and completed, affording at the very outset a wholesome object lesson that "time, tide, and trains wait for no man." It is a pity that Rudyard Kipling did not hear of this before he wrote "An Error in the Fourth Dimension;" but, unfortunately, the incident occurred a year or two too late. In all other respects the function was a highly successful one.

Singular occurrence.—At about 11 p.m. on 10th October, in Kotaura, Tukuoka Prefecture, more than 100 people, besides domestic animals and poultry, suddenly fainted, but with the help of their neighbours and such medical aid as was available, all recovered their consciousness after a brief period, and appeared little the worse. The occurrence is attributed to an escape of gas from an abandoned mine in the Fujidana coalfield, which is in the immediate vicinity.

New goldfields.—The discovery of gold in Hokkaido, the northern island, has recently been attracting considerable attention. The story goes that towards the end of last May a solitary tramp arrived in the little port or fishing village of Yesashi, where he made various purchases of provisions, &c., which he paid for in gold dust. Being questioned as to where he had obtained it, he would only reply, "Up the Horobetsu River," and hurriedly left the neighbourhood. As the Yesashi fishery has been exceptionally unprofitable during the last few years, the inhabitants were ready to seize any favourable chance that might turn up. Accordingly, a small search party, under the leadership of Mr. Taishu Horikawa, set forth, armed with picks and shovels, and, after wandering about for about 75 miles discovered traces of gold in the bed of a small brook at a spot which they afterwards found was only about 15 miles from their native village. Further discoveries followed, and it is now stated that the auriferous region covers an area of about 100 square ri, or about 25 miles square, in the Yesachi, Soya, and Mombetsu districts of the Kitami province. Yesachi is now a thriving little town, where about fifteen dealers in gold dust have their headquarters. It is said that the miners, who number about 7000, have already sent down gold to the value of £100,000, or thereabouts. Some of them have applied for licences, and taken up regular claims, but a large number of them wander about and dig and wash, or "prospect" at random, and as there is only a force of one inspector with ten men under him, they have things at present pretty much their own way.

Mining regulations.—It seems probable that a Bill will be laid before the approaching session of the Diet to remove the disabilities which at present prevent foreigners from participating in mining enterprises. The Tokyo Chamber of Commerce have already had the matter under discussion, and have laid their views on the subject, which are more or less favourable, before the Joint Conference of the Chambers of Commerce. As I suggested long ago, any relaxation of the existing restrictions in this respect will be brought about, not by the efforts of the foreign diplomatic representatives, but from a growing recognition of the fact that foreigners are not so wildly anxious as was expected to invest their capital in ventures for which they could obtain no valid title, and over which they could exercise no active control.

Sulphur mines.—In the expectation of a better state of things in the direction above indicated, it is stated that an American syndicate is already being formed to investigate the possibilities of extended operations in this field. Yezo, or Hokkaido, the most northern of the four chief islands, and the chain of small volcanic islands known as the Kuriles or Smoky Islands, extending thence to Saghalien, are well known as being rich in this substance, and likely to prove formidable competitors with Sicily. There are also many minor deposits scattered over the country generally. One, which I visited about five years since, may be taken as typical of many others. Shirane-san, or the White Mountain—there are several other mountains bearing the same name—can be easily visited from Kusatsu, the most celebrated hot springs in Japan, which are annually visited by thousands suffering from rheumatism, gout, &c., for the cure of which it is found extraordinarily efficacious. Although 7500ft. above sea level, it is not an imposing mountain, as the crater, which forms the summit, only rises slightly above a sloping plateau of considerable extent, covered with "a skeleton forest, whose every bough and twig"—see Murray's Guide—"though perfect in shape, remains blasted by the fumes exhaled during the eruption of 1882." It is also covered with huge rocks projected by the same and previous eruptions. Immediately ontside the crater were the refining works, where the sulphur was roughly refined and cast into blocks which were transported by pack horses. From the refinery a tramway led through a cutting in the wall of the crater into the interior at about the same level, which contained a lake of dilute hydrochloric acid. This formerly occupied nearly the whole of the crater, about 500 by 200 yards, but had been partially drained off by tunnels through the crater walls, until it occupied an area of about 250 by 100 yards. Skirting this, the tramway brought us at the far end, to a black seething caldron of perhaps 20 by 30 yards, as far as could be judged through the clouds of sulphurous steam, the mud and sand from the edges of which were being rapidly shovelled into tramcars and carried off, and as rapidly replaced from the nether regions. Round the rim of this caldron were eight or ten blowholes, belching forth jets of steam, and building up round each a pipe of almost pure sulphur deposit, just like so many yellow chimney pots. Of course, these were broken off and carried away as fast as they were formed.

I found some difficulty in reconciling my own impressions with the accounts of previous visitors, but this difficulty was explained by a violent eruption from the same caldron in 1897, which smothered the whole establishment, refinery, and workmen's houses under a shower of falling rocks, and scattered over a mile or more in every direction. Fortunately no lives were lost, but the enterprise, like many others of a similar nature, has been abandoned, at all events for the present. I may add that I have compared the accounts given by some half a dozen persons who have visited the spot during the last fifteen years, and no two of them agree as to the minor details, which is perhaps scarcely to be wondered at, as the circumstances are constantly changing.

INSTITUTION OF CIVIL ENGINEERS, GLASGOW ASSOCIATION OF STUDENTS.—The first general meeting of session 1899-1900 was held on the evening of the 4th inst. in the lecture-room of the Glasgow University, the meeting on this occasion being a joint one with the Glasgow University Engineering Society. Mr. A. B. Macdonald, M. Inst. C.E., the retiring president of the Civil Engineers' Association, introduced the new president, Prof. Archibald Barr, D.Sc., M. Inst. C.E., of the Chair of Engineering in Glasgow University. Dr. Barr thereupon delivered his presidential address, in the course of which he pointed out that engineering was a learned profession if ever there was one, and that engineers were all members of one profession, be their particular branch the design and construction of railways, locomotives, docks, machinery, waterworks, ships, or any work which was the product of turning the great sources of power in Nature to the use and convenience of man. There was, he declared, no narrow specialism about such men as Smeaton and Watt. Dr. Barr also showed, by many instances, how seldom it happened that a man exhibited any great or conspicuous originality in the line in which he had received special training, and he advocated greater breadth of interest amongst engineers, and urged the rising generation to seize every opportunity of gaining knowledge in more than one branch of the profession. There was a large audience, and at the conclusion of the address a very hearty vote of thanks was accorded to Dr. Barr. The syllabus of meetings and visits to works for the ensuing session of this Association, organised by the honorary secretary, Mr. Andrew Home Morton, Stud. Inst. C.E., is a highly attractive one, the readers of papers in most instances being men of more than local note, and the visits being to works of great interest in the neighbourhood of Glasgow, under the guidance of gentlemen who in every case have to do with their practical execution. Following the presidential address by Prof. Barr, Sir W. H. Preece, K.C.B., F.R.S., Past-president of the Institution of Civil Engineers, will, on December 18th, deliver an address on "The Functions of the Engineer."

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The position remains much as reported last week, and is certainly difficult to understand. The effect is a continued check upon buying, owing to the uncertainty of possible developments, whilst here and there speculative merchants do not hesitate to express the opinion that prices have reached the top, and to back up this opinion by offering to sell forward at considerably under makers' present rates. On the other hand, makers of raw material, both iron and steel, maintain an exceedingly firm attitude. They have very little to offer for some time forward, beyond the deliveries on account of contracts already entered into, and consequently they are under no necessity to give way in price to secure business in competition with the low-cut quotations of merchants. The position of finished iron and steel manufacturers is even stronger than that of pig iron makers. In many cases they have orders on their books that will carry them on till March or April next, and they are altogether indifferent about entertaining new business, quotations to outsiders being either refused or only given at a considerable premium upon present rates.

Most of the engineering firms are similarly situated, and generally have work on their books to keep them engaged for some time ahead, but although there is no present indication of slackening, a lessening weight of new orders offering has, if anything, become more noticeable during the last few weeks. Machine tool makers are, perhaps, not pressed with quite so much new work. Some of the heavy stationary engine builders are seeing the end of existing contracts with no corresponding weight of new work in immediate prospect, and the slackness in some branches of the textile machine trades to which I have referred previously, continues, so far as makers of spinning machinery are concerned. Other departments of engineering, such as boiler making, locomotive building, hydraulic and electrical engineering, show, however, no appreciable alteration in the position; the reports I receive from the representatives in various districts being generally to the effect that there is no falling off in new orders, whilst electrical engineers are even more pressed than ever with work both for lighting and motive power requirements.

There was again a quiet tone on Tuesday's iron market, the inquiries coming forward for either raw or finished material being for the most part restricted as closely as possible to hand-to-mouth requirements. This was the most noticeable in pig iron. Notwithstanding, however, a further easing down in warrants, and the fact that iron could be bought through second hands or out of store at very considerably below the full quoted rates, makers were holding firmly to their advance which was reported last week, any easing down at all being only where special prices had previously been quoted. With very little business being put through, prices for the most part were scarcely more than nominal. Lancashire makers are firm at full rates quoted last week for both forge and foundry, and the same remark applies to Lincolnshire makers. In the open market, however, merchants are offering to sell Lincolnshire for delivery next year at considerably below makers' present quotations, whilst a noticeable feature is that Middlesbrough can be bought through merchants at a lower price than makers are quoting for Lincolnshire. Derbyshire brands are not quite so strong at the maximum prices recently quoted, and foundry qualities delivered Manchester are to be bought at 78s. 6d. up to 81s. net cash, as about the top price, delivered Manchester. For Middlesbrough iron prices are irregular; merchants are sellers of ordinary G.M.B.'s at about 77s. 4d. to 77s. 10d. net, with makers asking from 79s. 4d. to 80s. 4d. by rail, Manchester. For Scotch iron it is difficult to get definite prices, but delivered Manchester docks about 81s. to 82s. might be taken nominally as average quotations for Eglinton and Glengarnock, in the open market.

With regard to finished iron the recent further advance in bars has somewhat checked new business, but there is still quite as much offering as makers care to entertain, and they are exceedingly firm at £9 10s. as the minimum for bars delivered Manchester. The representatives of North Staffordshire makers have withdrawn their basis list rates altogether, as it is anticipated prices may very shortly be officially advanced to £10 delivered here. In sheets there is a fair business coming forward at recent quotations, averaging about £11, and hoop makers are doing a moderate trade at the advanced official list of £9 17s. 6d for random, to £10 2s. 6d. for special cut lengths delivered Manchester, and 2s. 6d. less for shipment.

In the steel trade there is only a limited inquiry for hematites at makers' full rates of 90s. 6d. to 93s., less 2½, for No. 3 foundry, delivered Manchester, warrants having been something like 7s. to 8s. below makers' maximum prices. Billets are exceedingly strong, and makers are now asking up to £7 10s. delivered here. Bars are very firm at £9, to £9 10s. and £9 15s., with tank plates averaging about £9 2s. 6d. and boiler plates about £9 12s. 6d. to £9 15s. delivered here.

An extraordinary development of the engineering industry now in progress in the immediate neighbourhood of the Manchester Ship Canal, where quite a number of new and important engineering works are in course of erection, and rapidly approaching completion.

Mr. E. Kilburn Scott read before the members of the Northern Society of Electrical Engineers, on Tuesday, an interesting paper on various methods of suppressing arcs in switches, fuses, &c.

The general advance in prices for all descriptions of fuel that came into force with the commencement of the month would scarcely seem to be so readily established as had been anticipated. As I pointed out last week, the fact that whilst in the West Lancashire district engine fuel had been advanced 1s. 8d., Manchester firms had only put on 10d. per ton, created a difficult position where the two districts came into close competition, and this has necessitated a further consideration of the matter by the Coal Sales Association, representing West Lancashire. A special meeting of this association was held in Manchester on Tuesday, when the question was brought forward as to whether the members would be required to adhere to the full advance of 1s. 8d. per ton where they had to compete with collieries that had only raised their prices 10d., and ultimately it was decided that, under such conditions, they should be allowed to exercise their discretion as to whether they adhered to the full advance of 1s. 8d. or not. Another consideration that is largely influencing the position just now is the fact that the Lancashire advance is not being followed as yet by a corresponding upward move on the part of the Yorkshire collieries, although it is reported that a general advance in the last-named district is more than probable with the close of the month. Under these conditions it is, perhaps, not surprising that business since the commencement of the month has not been very pressing; buyers, in not a few instances, have been holding back from placing orders at the full rates now quoted, with the object of seeking supplies in other quarters on more favourable terms, and the situation has not been improved by the continued exceptional mildness of the season, which is keeping in check the ordinary winter requirements for house-fire consumption.

Common round coals, suitable for steam and forge purposes, continue in active demand, and strong at the full rates recently quoted, with supplies remaining rather short to meet requirements, and ordinary descriptions are readily fetching about 10s. 6d. at the pit. The present production of engine fuel at the Lancashire collieries continues short to meet requirements, largely owing to the quietude in the house-coal trade, and full rates are readily got in the open market, notwithstanding that slack is being obtained from Yorkshire for delivery in some outside districts at considerably below the prices Lancashire collieries are quoting. The general run of prices at the Lancashire collieries shows no very material change from those given last week, common slack being quoted 7s. to 7s. 6d.; medium, 8s. to 8s. 6d.; and best sorts, 8s. 6d. to 9s. at the pit mouth.

In the shipping trade, representatives of collieries generally report a very fair inquiry, but supplies are perhaps not quite so short as they have been, as, in some instances, where house coals have been accumulating under load at pits, these have been sent away for quick shipment clearance at practically steam-coal prices. For delivery at the High Level, Liverpool, or Manchester Ship Canal, steam coal is fetching from 11s. 6d. up to 12s. 6d. in exceptional cases for some special qualities.

Although the demand for coke continues in excess of the production, there has so far been no official further upward move on list rates, but it is considered that some advance will be forced on the trade before long, and it is probable a meeting of the Lancashire Coke Makers' Association may be held this month to decide what course to take. For the present, best Lancashire foundry cokes at the ovens remain at 28s., with 22s. quoted for good furnace qualities.

Barrow.—There is no material change to note in the position of the hematite pig iron trade. The demand is very full and consumers' requirements seem to be on the increase, but business with makers is restricted, as they cannot sell for early delivery, and are not disposed to sell largely forward in view of the prospect of a much higher plane of prices. Makers are quoting nominally at 78s. to 80s. per ton for mixed Bessemer numbers net f.o.b., and warrants are lower at 75s. 10d. net cash sellers, buyers 75s. 9d. During the week warrant stocks have been cleared to the extent of 2646 tons, and the stocks now held represent 209,044 tons, or 33,065 tons more than in the beginning of the year. There are still forty-seven furnaces in blast, as compared with forty in the corresponding week of last year.

Iron ore is in very active request, and native sorts are at 15s. per ton for good ordinary samples, with best sorts at 19s. per ton net at mines. There is a good trade doing in Spanish ores, which are selling at 18s. per ton delivered at West Coast ports, and the deliveries represent a very large weekly tonnage.

Steel makers are very busy, and report a continued brisk inquiry for all classes of steel as well from home as from foreign sources. There is not only an active but a growing inquiry for heavy steel rails, and the indications seem to point to a very much more active demand in 1900, particularly on colonial and home account. Prices are steady at £7 per ton, and orders are very fully held. In light rails and colliery sections there is a good trade doing, and tram rails are receiving much attention at present. The steel shipbuilding material trade is fuller than perhaps the activity, so far as new shipping tonnage on offer, would justify, but there is a very full call for ship plates and sections, and the former remain firm at £8 per ton. Billets, tin bars, hoops, sleepers, and other steel produce are in brisk request.

Shipbuilders are pushing forward with the big orders they have on hand, but are not booking any new ones at present.

The coal trade is very busy, and orders are not so readily met with supply as of late. Prices are very firm. The coke trade is brisk, and prices have advanced to 34s. per ton for Durham qualities delivered at West Coast furnaces.

Shipping at West Coast ports is very busy. The returns for last week show exports of pig iron at 11,906 tons, and steel at 11,878 tons, being an increase of 3386 tons of pig iron, and 98 tons of steel on the corresponding week of last year. The aggregate shipments this year have reached 489,956 tons of pig iron, and 455,930 tons of steel, being a decrease on the corresponding period of last year of 1616 tons of pig iron, and 30,595 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE coal trade in the South Yorkshire district remains in the prosperous state already reported. Values continue to harden, and confidence is widespread. This is due to two causes, first, the certainty of the wages question being settled without trouble by acceding to the advance which the men are asking for, and the second through the sustained briskness of business in all directions.

Although the weather has been against the household trade, stocks have not increased in spite of the abnormal output of several of the pits. The London and Eastern Counties trade is fully maintained, with local demand above the average. Seaborne coal has not been so heavily sent to the metropolis, and this has had some effect in sustaining values in the Yorkshire district. The secondary grades of coal are at present in greatest request. Best Silkstones fetch 11s. 3d. to 11s. 9d. per ton; ordinary from 10s. per ton; Barnsley house, 10s. 6d. to 11s. 3d. per ton; seconds, from 9s. 9d. per ton; nuts, 8s. 6d. to 9s. 6d. per ton.

In steam coal the railway companies are having large deliveries made under contract. Supplies for next year are being arranged for on a basis of 10s. 6d. to 11s. per ton for best Barnsley hards. The coalowners are standing out for 10s. 6d. for six months' contracts and 11s. for twelve months' contracts. This is the season when gas coal is in most urgent request, and supplies are pressed for. In engine fuel nuts make 7s. 9d. to 8s. 6d. per ton; screened slack from 6s. 6d. per ton; pit slack from 4s. 6d. per ton. In small coal for coking purposes, the increasing supplies do not cover requirements, and 17s. 6d. to 21s. per ton is easily secured.

The prices of pig iron continue very stiff. On finished iron an advance of 5s. for bars and 10s. for sheets is required. West Coast hematites are now quoted at 90s. to 91s. per ton; East Coast ditto, 88s. to 89s. per ton; Lincolnshire, No. 3 foundry, 72s. to 73s. 6d.; forge ditto, 69s. 6d. to 70s. 6d.; Derbyshire, No. 3 foundry, 73s. 6d. to 74s. 6d.; forge ditto, 78s. 6d. to 79s. 6d.; bars, £9 15s. to £10; sheets, £11 to £11 10s. Some anxiety has been expressed as to the future supplies of hematites. It is no secret that the home mines are getting worked out, with the result that increasing weights are being brought over from Spain.

In steels, particularly in Bessemer and Siemens, the higher rates mentioned last week, instead of checking the demands, have caused consumers to place heavy orders in view of future advances. Prices have advanced another 5s. per ton for Bessemer billets and 10s. per ton for Siemens-Martin billets. Bessemer billets now range from £9 per ton upwards, Siemens-Martin billets fetching £10 to £13 per ton, with every prospect of more money being demanded before the year is over. In all the rolling mills there is more work than the plant can cope with, orders placed months ago being now only in course of partial delivery.

Contractors who have to do with the South American trade report a heavy demand for Argentina. Rail orders for Buenos Ayres, and railway plant of all descriptions, have been exceptionally heavy during the whole year, and they are now heavier than ever. The whole of the South American markets are pressing for railway work, and the means of production are quite unequal to the demand.

The Sheffield Corporation have placed with the Barrow Steel Company fresh contracts for the supply of steel rails for the tramways under the overhead electric traction system now partially in operation. The total amount required under the extensions decided upon is 14,000 tons, some 7000 having been either delivered or under order, and the further contracts will be placed at the rate of about 1000 tons at a time. The section—108 lb. to the yard—is stated to be the heaviest in England. The new contracts, it is understood, have been placed at a considerable advance on previous contracts owing to the increased cost of materials, labour, and other causes which contribute to the production. The Sheffield Corporation are having their rails supplied in 30ft. lengths. The Glasgow Corporation, who are ordering from the same company, are having their rails supplied in 60ft. lengths.

NORTH OF ENGLAND.

(From our own Correspondent.)

WHILE all the finished branches of the iron and steel industries are in as active and prosperous a condition as they can well be, business in the pig iron market has been very slow this week, as it has been altogether disorganised by the unsettled state of the warrant market—a condition of affairs caused not by any actual decline in trade, but by purely speculative operations. A considerable number of holders of warrants have been endeavouring to sell out, their chief reason being that owing to dear money it has become very expensive to carry warrants, and as it is probable that money will keep dear, they think it well to unload, more especially as the quiet time of the year is at hand when prices usually decline. There has been so much pressure among these speculators to sell while they could realise substantial profits, that prices were quickly brought down; indeed, Tuesday's price, which was the lowest of the week, dropped to 67s. 9d. cash sellers, or 3s. 8d. less than the best price of last month. Since Tuesday there has been some improvement, Wednesday's close being at 68s. 4d. cash.

Makers have not been affected by the disorganised condition of the warrant market, for they have next to no iron to sell, even for next quarter; in fact, they were never so well off for contracts at this time of the year as they are at present, and they are practically independent of the changes in the warrant market. They do not believe that there can be any relapse of importance in the pig iron trade while the finished branches of the industry are so prosperous. They have, therefore, not conformed to the lower prices of warrants this week, and have generally refused to quote, but where a figure has been named by them it has not been below 70s. per ton for No. 3 Cleveland G.M.B. pig iron, which consumers considered too high, when warrants are so much cheaper. Merchants early in the week asked 68s. 6d., but since have raised the quotation to 69s., and they are almost as indifferent as makers about selling. Consumers, however, who were not particular about the brand supplied to them bought warrants rather than makers' iron, more especially as they could get prompter delivery of the former. No. 4 foundry has been quoted at 68s. 6d.; and grey forge, mottled, and white, all at 68s. Cleveland warrants are less unfavourably influenced by the speculation than Scotch—so much so that they have come within 2*l.* of the price of the latter, whereas the usual difference is between 4s. and 5s.

Hematite pig iron has never been so scarce as it is at present, and consumers complain that they cannot get all they require, which circumstance throws them back in the execution of their orders. A larger production cannot be brought about, because of the dearth of fuel. Makers have generally ceased to quote, but where they name a figure for mixed numbers it is 82s. 6d., which consumers are not generally prepared to pay. Rubio ore has been advanced in price, 20s. 6d. per ton being the minimum for delivery in this district.

The pig iron exports from the Cleveland district during November, though not on as large a scale as those of October, were, on the whole, very satisfactory; in fact, such November shipments have only once before been recorded, viz., in 1897. They reached 112,294 tons, while the October figures were 127,237 tons, and those of the corresponding month last year 80,554 tons. The average November shipment for the last ten years has been 82,000 tons, and last month's were therefore 36 per cent. above that average—a result with which producers have reason to be satisfied. The deliveries oversea, though considerably below those of October—73,895 tons against 91,521 tons—were the best ever reported in November. Exports to Germany were very good, no less than 46,805 tons being sent, whereas in November last year 21,938 tons was the quantity, and the tonnage forwarded to Belgium—6894 tons—has not been surpassed save once for many years, while it compares with only 1775 tons in November, 1898. To France the quantity was the largest of any month in recent years, reaching 6053 tons, against 730 tons in November, 1898. These extraordinary deliveries are brought about by the dearth of coke in the countries named. The traders would prefer to buy our coke, and make their own pig iron in greater quantities, but though they inquire diligently they cannot procure in this country anything like the tonnage of coke they need; they have to take pig iron instead. This has been so all the year, more or less, and the consequence is that Germany has had 515,109 tons of Cleveland iron, whereas last year the quantity was 285,729 tons; Belgium 50,084 tons, against 27,463 tons; and France 34,718 tons, against 29,459 tons. This has raised the shipments oversea this year to 795,375 tons, against 541,856 tons last year, and the quantity is 20 per cent. greater than that of the previous best year, 1897. Altogether this year, 1,260,815 tons of pig iron have been shipped from Cleveland, nearly a quarter of a million more than last year, and 8 per cent. more than in 1897, which heretofore has been the record year of exports. The deliveries to Scotland have fallen off, indeed, they are this year the smallest that have been recorded since 1893, reaching only 370,511 tons. This is due to Cleveland prices being relatively higher than Scotch.

Connal's stock of Cleveland pig iron declined 10,036 tons last month, dropping to 74,444 tons, which is the smallest quantity reported since 1892; and the stock of hematite pig iron declined 2285 tons, only 10,668 tons remaining in stock at the close.

The ironmasters of the Cleveland district have combined to address a special letter of complaint to the North-Eastern Railway Company relative to the short supply of trucks, owing to which they are put to much inconvenience, and cannot deliver their iron as promptly as is required. This inconvenience has been experienced every year about this period for a number of years past, but this year it appears to be more acute than ever, though the railway company have done a good deal in the way of building and buying additional rolling stock, besides which, they have hired wagons from a number of other railway companies. Ironmasters would provide their own trucks, but the railway company does not favour the employment of private wagons on their main lines.

The manufactured iron and steel industries are exceedingly well employed, and producers are, in fact, unable to cope with the amount of work pressed upon them. They cannot guarantee anything like early delivery, and those who order now must be content to wait for a long time before they can get possession of the iron or steel they need. Under circumstances like these the market is totally unaffected by the fluctuations in warrants, and, what is more, it is generally held that there can be no drop of importance in the price of pig iron while the finished iron branches are so prosperous. Manufacturers are quite at ease about their future, and the tendency of prices is upwards. Iron and steel ship plates are at £8; steel boiler plates, £9 5s.; iron and steel ship angles, £7 15s.; common iron bars, £8 15s.; all less 2½ per cent. The production of iron ship plates in this district is now confined to two firms, and they have no difficulty in getting for them the same price as is paid for steel plates. Heavy steel rails are firm at £7 net at works.

The North-Eastern Steel Company, Limited, Middlesbrough, is about to spend £100,000 in important extensions of its plant and rolling mills, so that they may take up other profitable branches of manufacture, and to enable them to carry out this work, as well as pay off some 5 per cent. Terminable Debentures, they are issuing 4½ per cent. First Mortgage Debenture Stock to the extent of £250,000. The company was formed in 1881 to establish steel works in Middlesbrough for the manufacture of steel rails and other products chiefly by the basic process. They started operations in 1883, and since 1884 have never paid a lower dividend than 5 per cent. per annum. The dividend for 1897 was 6½ per cent., and a like rate was paid last year. The annual profits for the last three years have been on the average £40,384 per annum, and the works, land, &c., are valued at over £447,779.

Mr. Douglas Upton, who has been for a number of years general manager of the Stockton Malleable Ironworks, at Stockton, terminates his connection with the works at the end of the year, and will remove to Darlington. The Malleable Works have been acquired by the South Durham Steel and Iron Company, Limited, who also have the Moor Iron and Steel Works at Stockton, and the West Hartlepool Steel and Ironworks, and are the largest producers of plates in the district.

The Stockton Corporation have appointed as their resident electrical engineer in connection with their works now in course of erection, Mr. Joseph J. Smith, who is manager of the Altrincham Electric Works, near Manchester. Mr. Smith is the son of Alderman G. F. Smith, of Stockton, and served his apprenticeship as an engineer at Messrs. Blair and Co.'s works, Stockton. Afterwards he went to sea, and rose to the rank of chief engineer. He then took up electrical work, and served with Messrs. Scott and Mountain, Newcastle-on-Tyne. He superintended many of their important electrical contracts in various parts of the country.

Mr. Harold Copperthwaite has retired from the position of engineer of the southern division of the North-Eastern Railway, after a long service in that capacity, and the officers of the company a few days ago made a presentation to him. This consisted of a portrait of himself, painted by Mr. Charles Holroyd, head of the Tate Gallery, and a cousin of the recipient. Mr. G. S. Gibb, general manager, made the presentation.

The River Wear Commissioners have under consideration a scheme for the construction of a large new graving dock, to be not less than 559ft. long and about 75ft. wide, with a corresponding depth in the sill. The Commissioners recognise the necessity for such a dock on the Wear, in order to accommodate the larger sized ships of the present day. The Board, the chairman explained, had been in negotiation with Sir Andrew Noble, on behalf of Armstrong, Whitworth, and Co., with a view to that firm joining the Commissioners in the making of a dock which would be capable of accommodating the largest ships in the navy. The negotiations went on for some time, but at last the Elswick people decided to avail themselves of a dock that was in progress on the Tyne. The Wear Commissioners are therefore taking up the matter by themselves.

In connection with the dispute between the North-Eastern Railway Company and a section of its men, the employers have proposed the establishment of a Board of Arbitration to deal with all difficulties that arise between the employer and employed, but the men are not agreeable to this until their present grievances are disposed of.

The coal trade is extraordinarily brisk; indeed, some coalmasters have never had experience of so active a period, and there is every reason to believe that the prosperity will continue, as consumers and merchants are very anxious to buy for next year's delivery, and are paying present prices readily. It seems almost impossible just now to satisfy the requirements of customers, and prices are moving upwards. Thus best steam coal has been sold for delivery over the whole of next year at 15s. per ton f.o.b., but the general quotation varies from 14s. to 14s. 6d., and smalls are sold at from 8s. to 8s. 6d. Gas coals have been put up to 15s. per ton f.o.b., and unscreened bunkers at 13s. 6d. to 14s. Coking coals are sold at from 14s. to 15s., but there is not much available for sale. Foundry coke is quoted at 30s. per ton f.o.b., and blast furnace coke at 23s. to 24s. for medium qualities delivered at the furnaces, but considerably more has been paid for delivery this month, as ironmasters are apprehensive of very short supplies on regular contracts at Christmas.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow iron market was comparatively firm at the beginning of the week. A good business was done in Scotch iron on Monday and Tuesday, and there was more doing than usual in Cleveland iron for future delivery. Later in the week unfavourable cablegrams from America, representing a fall of half a dollar in pig iron, had a rather depressing effect, especially as this is the second week in succession in which unfavourable news had come from the States. Holders of pig iron became somewhat nervous, and there was also an opportunity for the "bears," the result being a sharp decline in prices. Business has been done in Scotch warrants from 69s. 5½d. to 68s. 7½d. cash, and 69s. 9d. to 69s. one month. Cleveland iron sold from 68s. 6d. to 68s. 4d. cash, and 69s. to 68s. 3d. one month. Transactions took place in Cumberland hematite warrants from 76s. 5d. to 75s. 5d. cash, and 76s. 10½d. to 75s. 11d. one month. From the lower of these rates there was subsequently some improvement.

While the speculative market is disturbed by American advices of a depressing character, there is no abatement in the demand for pig iron for home consumption. Makers are disposing practically of all they can make, besides drawing upon stocks. To what extent the latter have been reduced in makers' yards will not be known until the annual official returns are issued in the beginning of January. The stock of pig iron in Connal and Co.'s Glasgow stores shows a further reduction in the past week of 3850 tons, and a total reduction since the beginning of the year of 56,160 tons.

The prices of this special brands of makers' iron are firm, being comparatively little affected by the state of the warrant market. Govan, f.o.b. at Glasgow, No. 1, is quoted 71s. 6d.; No. 3, 70s. 6d.; Wishaw and Carnbroe, Nos. 1, 80s.; Nos. 3, 76s. 6d.; Clyde, No. 1, 83s. 6d.; No. 3, 79s.; Gartsherrie, No. 1, 85s.; No. 3, 79s.; Summerlee, Calder, and Shotts, Nos. 1, 85s.; Nos. 3, 80s.; Coltness, No. 1, 88s.; No. 3, 81s.; Glengarnock at Ardrossan, No. 1, 82s. 6d.; No. 3, 77s.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, Nos. 1, 79s.; Nos. 3, 77s.; Carron at Grangemouth, No. 1, not quoted; No. 3, 81s. per ton.

Scotch-made hematite is in good demand by the steel makers, and makers quote 86s. per ton for delivery at the steelworks.

The shipments of pig iron from Scottish ports in the past week amounted to 6405 tons, compared with 3197 in the corresponding week of last year. Of the total there was despatched to Canada 100 tons, India 57, Australia 895, France 263, Italy 490, Germany 722, Holland 846, Belgium 60, Spain and Portugal 100, China and Japan 135, other countries 60, the coastwise shipments being 2677 tons, compared with 2135 in the same week of last year.

The finished iron and steel trades are very busy. There is a great deal of work in hand, and prospects for the future are satisfactory; the main trouble of manufacturers is the increased cost of production resulting from advances in raw material and in fuel.

The engineering trades are very busy. Locomotive engineers are full of work, and so are marine engineers and makers of sugar-crushing and other plant.

The coal trade is very active, and prices are firm at the figures quoted a week ago. Colder weather has improved the demand for household coals for home consumption, and the shipments are heavier than in the previous two or three weeks. Compared with the preceding week, the aggregate clearances from the Scottish ports show an increase of fully 20,000 tons. There has in the last few weeks been a heavy demand for coals for shipment to Mediterranean ports, and a very considerable proportion of these fixtures has to be sent off before the beginning of the year. The consumption at the steel and iron works at home continues very heavy.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

AT the Coalowners' Association meeting, held in Cardiff after my despatch last week, the result of the audit for the past two months was announced, to warrant an advance of 1½ per cent., making the wages on and from December 1st to be 30 per cent. above the standard of December, 1879. This has not given the colliers satisfaction, a much larger advance having been anticipated; but, on consideration, I have no doubt they see that they were a little too sanguine. October prices were not so good as those of November. For instance, October prices for best steam were 14s. 6d. to 15s. 6d., and other coals in proportion. November prices were 20s. to 21s. 6d., and the rest in accord. If the coal trade—as appears likely—is well maintained forward, the next audit will tell. But it must not be overlooked that large quan-

tities of coal have been despatched foreign at lower figures than current.

Mr. D. A. Thomas, M.P., who is well informed on coal business and prospects, gave some interesting facts at a meeting held in Cefn Coed on Monday. He admitted that he was disappointed about the audit, but they might look for another advance in February, and a still larger one at the April audit. He looked forward with confidence to a long period of prosperity. High as prices were, there were no signs of their being affected by foreign competition. Germany, Belgium, and France were less able than ever to meet their own requirements. As for the United States, Pocahontas coal was doubled, and now was £1 per ton. The war in South Africa had no doubt aided in the rise of price, but the demand for Welsh coal was coming in from all parts of the world, and was increasing.

During last week all the Welsh ports have exported coal largely. Cardiff was very busy. Swansea had almost a record week, despatching 70,000 tons coal and patent fuel, France taking 26,000 tons coal. Newport, too, was above the average, sending foreign 65,793 tons, and coastwise 15,775 tons.

Mid-week on 'Change, Cardiff, it was stated, but not confirmed, that a large firm had booked an order for over 1900 at 18s., less 2½, best steam, and another for 16s.

The Portugese railway contract has been secured by Cory and Sons, Cardiff and Newport; 45,000 tons for Lisbon, 10,000 tons for Oporto, delivery between January and November, price 21s. 1½d. c.i.f. This is regarded as low. The next lowest tender was 23s. 10½d., and the next 24s. 3d. Swansea has suffered a little in its coal trade by the temporary stoppage of the colliery of Cwrt-y-Bettws, in the Swansea Valley, owing to a wage dispute. The pressure for coal has been great, and at Felinfran and others, supplies are short of the demand. New collieries are being opened at Llangefelach and Treboeth. Still there is not much cause for complaint at port, returns all round showing an excess of 20,000 tons over corresponding week. The characteristic of Swansea is the varied industries of the place. This is shown well by its imports. Last week, in addition to large quantities of pig iron and scrap steel, it imported 1650 tons of pitwood from France, 1850 tons ore from Spain, 100 tons general Belgium, 374 tons pitwood Norway, 390 tons deals Sweden, 300 tons general Hamburg, 1495 tons calamine, 135 tons blende Italy, 1350 tons copper ore, Bolivia.

This week the Exchange, Cardiff, has been in a very active condition, and as a good deal of tonnage has come in coalowners were besieged with inquiries for steam, house, and Monmouthshire coals. Small steams, which have flagged now and then, were a good deal in evidence, particularly the kind suited for bunkers. Closing prices, mid-week, were as follows:—Best steam, 20s. to 21s.; seconds, 18s. 6d. to 19s. 6d.; drys, 18s. to 18s. 6d.; best Monmouthshire, 17s. 6d. to 18s.; seconds, 16s. 3d. to 16s. 6d.; best steam, small, 11s. 6d. to 11s. 9d.; seconds, 10s. 9d. to 11s.; best households, 16s. 6d. to 17s.; No. 3 Rhondda, 18s. 6d. to 19s.; brush, 14s. 6d. to 15s.; small, 12s. to 12s. 6d.; No. 2 Rhondda, 15s. 6d. to 16s.; through and through, 12s. to 12s. 6d.; small, 9s. to 9s. 6d. Market firm with upward tendency. Patent fuel, 18s. to 20s. Coke is in a healthy condition; house and foreign demands are large. Prices:—Furnace, 26s. to 23s.; foundry, 29s. to 30s.; special foundry, 35s.

Swansea coal prices: Anthracite, 15s. to 16s.; seconds, 13s. to 14s. 6d.; ordinary large, 11s. 6d. to 12s. 6d.; small rubbly culm, 6s. to 6s. 6d. Steam coal, 18s. to 20s.; seconds, 16s. to 17s.; bunkers, 12s. 6d. to 13s.; small, 9s. to 9s. 6d. House coals according to arrangement. Patent fuel, 15s. to 16s. Coke, furnace, 25s. to 26s.; foundry, 27s. 6d. to 30s. Iron ore, Tafna, 17s. 6d. to 18s. 6d.; Rubio, 18s. 6d. to 19s. 6d. Newport and Cardiff prices vary slightly: Tafna, 17s. 6d. to 18s.; Rubio, 19s. to 19s. 3d. Pitwood at Cardiff a good average demand, prices 20s. to 20s. 6d. Swansea prices, 19s. 6d. to 20s. per ton into trucks.

Business in the share market continues brisk. Ebbw Vale shares have been done 11⅜ and 11½; Lockett's Ordinary, 9¼; Newport, Abercarn, 9; Norths, Ordinary, 5-9-32; Tredegar Iron A, 75s. 9d., 75s. 6d.

Brecon and Merthyr railways last week showed an increase of £335. Taff Vale a decrease of £190. Llanelly and District Electric Lighting and Traction Company has been registered with a capital of £50,000 in £1 shares.

Imports of the week have included a large quantity of iron ore for the chief iron and steel works of Monmouthshire, Blaenavon, and Ebbw Vale—which continues in a brisk condition in all departments—also for Cyfarthfa and Dowlais. A contemporary suggests that stocks must be large, but late consignments are simply run from main to private lines, and then straight up to the furnaces. Dowlais received this week a quantity of spiegel iron and manganese iron from Middlesbrough. The outgoing consignments have been very marked. They include consignments of merchant bars, tin bars, steel rails, and plates. At some of the principal works the steel made is more adapted for rail, plate, and bar than for Sheffield use, but it is understood that the croppings and rail ends are in strong request, and are worked up again in the Midlands.

Mid-week on 'Change, Swansea, it was reported that pig iron, on account of speculative movements, had been fluctuating, though makers' prices are firmer. Prices of finished iron and steel are still advancing; buyers stated that they found it almost impossible to place orders, make having been oversold. Midland buyers were in evidence. Latest prices are:—Glasgow warrants, 68s. 9d., 68s. 1½d., 68s. 2½d., cash buyers; Middlesbrough No. 3, 68s., other numbers in proportion; hematite warrants, 75s. 5d. for mixed numbers f.o.b., Cumberland according to brand; Welsh hematite, 82s. 6d. to. 85s.; Welsh bars, £9 to £9 10s.; angles at usual rates. Sheets, steel and iron, £9 15s. to £10 10s.; steel rails, heavy, £7 10s. to £7 15s.; light, £8 10s. to £9. Bessemer steel tin-plate bars, £6 15s. to £7; Siemens, £6 15s. to £7. Tin-plates: Bessemer steel cokes, 15s. 9d. to 16s.; Siemens, 16s. to 16s. 3d.; ternes, for double box, 28 by 20 C, 28s. 6d. to 33s. 6d.; best charcoal, 16s. to 17s.; big sheets for galvanising, 6ft. by 3ft. by 30 G, per ton f.o.t., £14 15s. to £15; finished black plates, £12 10s. to £12 15s.; Canadas, £10 10s. to £11; block tin, £126; spelter, £20; Chili bars, £74 10s. to £72 10s.; lead, £17 10s.

The drive going on in the steel bar trade is telling on the machinery, repairing is to be seen in many quarters. At the Midland works in the Swansea Valley last week, the whole of the mills were at a standstill several days, but are now making up for lost time. A breakage also occurred at Upper Forest, and caused a delay of two days. Swansea hematite blast furnaces are exceptionally busy. A large blast engine is now being erected, and will precede the building of another furnace. The adjacent smelting shop is in full operation, and one at the Millbrook steel furnaces, started by this energetic company, has begun producing. Cwmfelin, Duffryn, Upper Forest, and Pontardawe works are all busy. Engineering sheds of the Gloucester Wagon Company, as well as other industries, are full of work. Spelter establishments are busy, and a new silver works is stated to be projected.

The shipments of tin-plates last week were 40,898 boxes; received from works, 54,013 boxes; present stocks, 158,566 boxes. Loading has been entered for various destinations, one for New York, one for Lisbon and Oporto, and to the following:—Nantes and Bordeaux, Hamburg, Baltic ports, Copenhagen, Antwerp, Amsterdam, and Rotterdam. Continental orders for tin-plates and black-plates are steadily increasing. Prices, as will be seen by quotations, remain very firm, therefore vigorous efforts are being made to get them lower. The tendency is upwards.

On Tuesday Ystalyfera works were brought to the hammer at Swansea, and were knocked down to Dr. Newton, Mumbles, for £2900; stock extra, £2500.

Work has been resumed at Cwrt-y-Bettws Colliery, and Rock Colliery, Clydach-Merthyr men, Swansea district, remain out. They are fighting for "Mabon's" day.

One of the oldest Cardiff firms, John Williams and Sons, iron merchants, founders, &c., has been formed into a limited liability company, capital £60,000, of which the directors take £30,000, and £26,000 5 per cent. preference shares have already been applied for.

The strike of the cold roll boys at the Old Castle, Llanelly, which caused the works to be stopped last week, has, I am glad to state, been brought to an end, and operations have been resumed.

Apart from some trifling differences in the western coalfield, labour movements are of trifling note. Mr. Pickard, referring to Wales, said that he had heard from good authority that 90,000 men were now paying into the South Wales trade union. He considered a general advance likely. Colliery shares are firm.

Mr. F. W. Blackler, assistant sec., Mount Stuart Dry Dock, has been appointed secretary of Barry Graving Dock. The vacancy was caused by the death of Mr. T. D. Wood. I hear that there were no less than 144 applications.

It is thought that a satisfactory settlement of the Cardiff ship joiners' dispute is pending.

Neath is coming to the front with a movement for securing a new watershed. A committee has been appointed of representatives of Aberavon, Briton Ferry, Neath Town Council, and Neath District Council, who have decided upon calling in an expert, at a cost not exceeding £300, to report.

I must note that Welsh colliers are in a line with artisans generally. In many districts they have requested their officials to keep back 3d. per week per man for the soldiers' fund as long as the war lasts.

NOTES FROM GERMANY.

(From our own Correspondent.)

THERE has been a good deal of vigour displayed in the iron and steel trades of Rheinland-Westphalia and Silesia. In nearly all departments demand has continued excellent, and the fact that consumers and dealers are most anxious to provide themselves as fully as possible with supplies, even if they have to pay heavily for them, shows how confident the feeling is all round. Though the present time is usually a very quiet part of the year with regard to the trade in iron and steel, there is no abatement felt in activity this year, and it is quite an exception where the mills and forges are not booked forward far into next year.

For crude iron an exceptionally large demand continues to be experienced. How strong inland consumption in pig iron has been during the month of October, is seen by the following figures:—Production in pig iron was 72,157 t., stocks amounting on 11,142 t.; increase in output was 5302 t., against September of present year, while the decrease in stocks was 1348 t.; consumption has accordingly increased considerably (6650 t.) Silesian iron masters are quoting M. 80 p.t. for good forge quality, and M. 93 p.t. for best foundry pig, while Bessemer stands on M. 87 to 88 p.t. Requirements in scrap iron for this winter's consumption are fairly large and prices remarkably firm. Scraps are sold at M. 72 to 75 p.t., and old iron rails at M. 105 to 107 p.t., free place of consumption. A very satisfactory condition of affairs prevails in the malleable iron department. There have been a good many inquiries coming in upon the week, and more will come in within the course of this month as spring orders are now beginning to be placed. Plate and sheet makers are well supplied with contracts, and there will be no lack of work at the mills for months to come. In the Siegerland M. 210 p.t. has been realised for sheets, and heavy plates were quoted M. 195 to 200 p.t.

Very full activity is being maintained at the rivet works, especially in the Siegerland, where the old firms have been compelled to enlarge their establishments, and a good number of new shops have been built and are in lively operation. Girders continue in pretty good call, and the outlook for next year's trade in this article is favourable; spring orders are plentiful already. Basis quotation is still M. 150 to 155 p.t. free at works.

The coal trade in Rheinland-Westphalia, and in all the other coal-producing districts of Germany, is better than it has ever been before. Inland consumption increases from week to week, and exports have been pretty regular, too. Both from Russia and from Austria-Hungary a fair number of orders have lately been received. At one of the large Silesian collieries considerable damage has been caused by fire a short time ago, and as the pit, which yielded 280,000 t. last year, cannot be worked regularly for some time, a falling off in output will be felt.

Sales in plates, bars, and general hardware are pretty satisfactory on the Austro-Hungarian iron market; other articles, such as girders and structural iron, show a falling off in demand against previous weeks. Rails, too, are inclined to be dull, at least n Austria, where Hungarian competition is keen and often successful. The Hernadthal Company—Hungarian—has sold over 100 wagons rolling material to the Austrian North-Eastern Railway. Regarding the condition of prices for raw and finished iron, no change can be reported to have taken place for some weeks past. Now and then a slight reduction is agreed to where makers are specially anxious to obtain an order, but as a rule the prices for iron and steel are showing firmness.

The brilliant activity previously noted in the Belgian iron trade has been fully maintained all through last week, and has even been showing an improvement in some branches. Pig iron is, if possible, in better demand than any other sort of iron, and there is a continued upward tendency felt in quotations, which are very high already. Pig iron from the Longwy district stands on 100f. p.t. at works, which is equal to about 108·50f. p.t., free place of consumption. Forge pig from Charleroi is quoted 106·50f. to 107f.; Luxemburg ditto, 103f. p.t. Merchant iron remains very firm, and is briskly called for, fetching 220f. to 222f. p.t. for home and foreign consumption. Girders are paid with 200f. p.t. for export, and 205f. p.t. for local consumption.

From week to week the healthy tone of the Belgian coal trade is becoming more pronounced, and it is difficult to give the exact prices of the last weeks, as buyers have to pay what the pits ask, and even then the former are glad to find their orders attended to, as the collieries have considerable difficulty in satisfying their customers. Under these circumstances one need not be surprised that quotations continue to move upwards, and so 35f. and even 40f. p.t. are reported to have been given for coke, and coking coal has been bought at 18f. to 20f. p.t. The fact that the Belgian State Railways had to buy 200,000 t. coal from England, the Belgian pits being unable to promise delivery, shows how scarce coal is getting in Belgium. Export in artificial coal from Belgium was, for October of present year, 45,600 t., against 69,200 t. in 1898 and 38,300 t. in 1897.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

PIG iron is in good request at firm prices, namely:—Staffordshire cinder forge, 65s. to 70s.; part mine, 75s.; all mine, 77s. 6d. to 82s. 6d.; best ditto, 90s. to 92s. 6d.; cold blast, 120s. to 127s. 6d.; Northamptonshire, 72s. to 74s.; Derbyshire, 73s.; to 75s.; North Staffordshire, 75s. to 77s.

Singles are quoted £10 2s. 6d. to £10 7s. 6d., doubles £10 5s. to £10 10s., and trebles £10 17s. 6d. to £11 2s. 6d.

The new advance in iron workers' wages of 3d. per ton for puddlers, and 2½ per cent. for millmen, came into effect on Monday last, thus bringing puddlers' wages up to 9s. The advance of 8s. 6d. in the average bi-monthly selling price would have been larger but for the fact that some old contracts were included. The average net selling price was £7 12s. 1·63d. per ton, again t £7 3s. 7·86d. per ton in the two preceding months. The production of the twelve selected firms during September and October was 29,167 tons, an increase of 5873 tons as compared with the previous two months.

It is in consequence of this advance in wages that the marked bar firms have raised their prices 10s. per ton, thus making the new figure £10 10s. as the basis price for marked bars. The L.W.R.O. brand of the Earl of Dudley is quoted £11 2s. 6d. Second grade bars by the twelve selected firms are £9 15s.; and common unmarked, £9 5s. to £9 10s.

Staffordshire steel is quoted as follows:—Bessemer billets and blooms, £7 5s. to £7 10s.; best Siemens ditto, £7 10s. to £7 15s.; mild steel bars, £8 10s. to £9; steel plates, £9 5s. to £9 10s.; steel girders and angles, £8 to £8 10s.

Copper is steady and fairly active, with cash at £73 12s. 6d.; December prompt, £73 10s. and £73 12s. 6d.; January, £73 5s. and £73 7s. 6d.; February, £73 2s. 6d.; and three months £72 10s. to £72 15s.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM-COAL market keeps very strong, and prices are firm. The same remark also applies to the house coal. Steel and ironworks fully employed, and prices for finished iron, steel, and tin-plate bars are advancing. Tin and copper both easier than last week's quotations. Exports for week ending December 2nd were:—Coal: Foreign, 65,793 tons; coastwise, 15,775 tons. Imports for week ending December 5th were:—Iron ore, 3515 tons; pig iron, 530 tons; tin-plate bars, 350 tons; manganese, 1200 tons; slate slabs, 1396 tons; pitwood, 4652 loads.

Coal: Best steam, 18s.; seconds, 16s. 6d. to 17s.; house coal, best, 15s.; dock screenings, 10s. 6d.; colliery small, 10s.; smiths' coal, 10s. 6d. Pig iron: Scotch warrants, 63s. 9d.; hematite warrants, 75s. 11d. f.o.b. Cumberland; Middlesbrough No. 3, 68s. 3d. prompt. Iron ore: Rubio, 19s. to 19s. 3d.; Tafna, 17s. 6d. to 18s. Steel: Rails—heavy sections—£7 10s. to £7 15s.; light do., £8 10s. to £9 f.o.b.; Bessemer steel tin-plate bars, £6 15s. to £6 17s. 6d.; Siemens steel tin-plate bars, £6 15s. to £7; all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 15s. 9d. to 16s.; Siemens—coke finish—16s. to 16s. 3d. Pitwood: 20s. London Exchange Telegram: Copper, £73 12s. 6d.; Straits tin, £125. Freights: Steady.

TRADE AND BUSINESS ANNOUNCEMENTS.—The address of the Cleveland Machine Screw Company will be 203a, Chapel-street, Salford, Manchester, after the 9th instant. They are removing in order to secure a more central position.—Mr. Thomas Smith, of Rodley, near Leeds, informs us that he has opened a London office at 9, Victoria-street, Westminster, S.W., under the management of his son.—Johnson and Phillips announce the removal of their Manchester establishment to Duchy-chambers, Clarence-street, Albert-square (North), Manchester.—The Gloucester Railway Carriage and Wagon Company, Limited, announces that its City office has been closed, and requests that all communications be addressed to Gloucester, or to No. 1, Victoria-street, S.W.—The British Westinghouse Electric and Manufacturing Company, Limited, have taken over the British and Colonial business of the Westinghouse Electric Company, Limited, together with the services of their engineering and technical staff, and have opened offices at Westinghouse-building, Norfolk-street, Strand, London, W.C.

"HAYSTACK" MARINE BOILERS.—In the boiler works of Hutson and Sons, Glasgow, some interesting contracts are at present on hand, in the way of "haystack" type of boilers for river and channel passenger steamers. A. and J. Inglis, of Partick, adopted the haystack type of boiler in the North British Steam Packet Company's new crack steamer Waverley, which has proved herself the speediest paddle steamer of her size on the Clyde. The arrangement and preparation of parts of the "haystack" boiler are such as to preclude the ordinary run of boilermakers from undertaking work of the kind without previous experience. The amount of flanging, curvature, and smithing of parts is great, and is of such a character as to necessitate hand-work entirely. Hutson and Sons, all along experienced in this kind of boiler work, have within the past few years turned out some six or seven such boilers to stand a high working pressure, which are now on board paddle steamers plying chiefly in South of England waters. They have at present in hand four boilers of the type, some of them to be worked at 110 lb. pressure, and to furnish steam for engines of 2600 indicated horse-power. The weight of a boiler of this capacity is only about fifty tons, the amount of heating surface being 4500 square feet.

THE DYNAMITE FIELD GUN.—Some experiments were carried out on Monday, 4th inst., at Crayfordness, by the New Explosives Company, Limited, of Stowmarket, for and on behalf of the Sims-Dudley Defence Company, of New York, the inventors and proprietors of the dynamite field gun; the object being to ascertain the relative merits of (*a*) explosive gelatine, as hitherto employed, as the bursting charge for the shell of this gun, and (*b*) high-density gun-cotton, as recommended by the Stowmarket Company, as a safer and more effective explosive. The experiments resulted, we are informed, entirely in favour of wet gun-cotton having a dry gun-cotton primer. The fragmentation of the shell, and the craters made in the ground following the explosion, comparing more than favourably with the effects produced by the explosive gelatine charge. This dynamite gun has recently been tentatively adopted by the United States Government, and twelve of them have been sent to the Philippines. Trials have also recently been conducted before the Norwegian military authorities. The War-office authorities have, we understand, just placed two contracts for the supply of cordite with the New Explosives Company, Limited, of Stowmarket, necessitating day and night work in this department of the company's factory for some time to come.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineers: J. Kerr, to the Latona, on commissioning; J. R. D. Johnson, to the Polyphemus, on recommissioning; W. H. Skinner, to the Vivid for the Talbot; J. Moysey, to the Duke of Wellington for the Mercury; T. Whebby, to the Royal Arthur for the Katoomba, to be lent to the Ringarooma; J. J. Frost, to the Vivid for the Bulwark, and W. Lonnon, to the Vivid for the Agamemnon. Staff engineers: E. Cornish, to the Pembroke for the Venerable, and E. G. P. Moffett, to the Pembroke for the Hawke. Chief engineers: H. C. W. Peel, to the Severn for the Circe; H. T. Liversedge, to the Pembroke, additional, and to the Dryad, on commissioning; E. Swinney, to the Scout; L. Backler, to the Indefatigable, and S. A. Screech, to the Monarch, for transport staff; F. P. Smith and G. R. Tayler have been promoted to the rank of staff engineer with seniority. Engineers: H. W. Heyes, to the Pembroke for the Coquette; Victor de Paris, to the Pembroke for the Porcupine; W. Rattey, to the Duke of Wellington for the Bullfinch; F. Wise, to the Pembroke for the Cyclops, all in lieu of a chief engineer; C. G. Ware, to the Furious; C. Laughton, to the Vivid for the Gipsy; G. E. A. Crichton, to the Indefatigable, reappointed for three months from date of recommissioning; R. J. Block, to the Vivid for the Ocean; J. F. Bushby, to the Howe, and R. Bryan, in lieu of a chief engineer, to the Buzzard. Assistant engineers: E. H. Marshall and C. J. Greene, to the Polyphemus, and J. Murphy, to the Latona. Probationary assistant engineer: C. L. Warren, to the Indefatigable, and for recommissioning.

THE FIREPROOFING OF FLOORS.

THE following is an abstract of a paper read by Mr. J. H. Blakesley, M.A., A.M.I.C.E., before the Civil and Mechanical Engineers' Society yesterday. The subject of fireproofing being such a large one, it is desirable to restrict the observations in this paper to a small branch of the subject, and as a very exhaustive historical account occurs in Vol. cv. of the "Minutes Institution of Civil Engineers," in a paper by Mr. Webster, it is deemed advisable to merely review a few typical structures here in their relations to the general principles to be followed. Progress in these inventions has been retarded by the growing necessity for cheapness, which is not counteracted by occasional fancy specifications. Chief objects in fireproofing should be to adapt the protection to the actual needs of the building, so as not to increase cost unnecessarily, to avoid thrust on the side walls, and depth or thickness of floor, which increases the amount of brickwork in the building; and lastly, strength in proportion to the weight of the floor. In most cases the floor between the supporting joists is stronger than the joists themselves, and any great excess of such strength over that of the joists is therefore superfluous.

With regard to materials, hydrated cements should be avoided when exposed to very fierce heat, though usefully employed when covered by more refractory substances. The advantages of porosity are generally non-conduction of heat and lightness. The disadvantages are the liability to the generation of stresses in the pores when the heated substance is played upon by cold water, and consequent rupture. Maurer's and Wright's bricks are highly porous, and in some cases have shown good results. Coke breeze concrete is another, but of variable fireproofing power, according to quality, and some sorts apparently make better fuel than fireproofing material. There is a danger in the best non-conducting substances, owing to the stress produced by suddenly cooling the surface, which is likely to cause rupture; and here a hydrated plaster may with advantage be used to protect the principal structure from sudden changes, although not contributing itself to the strength. Fireclay appears to be the best substance for resisting heat, and, if properly worked is of considerable strength, as shown by tests made by the author. Nevertheless, these clays, which are vitrifiable, should be avoided, though stronger than others.

In the old brick arch system the chief disadvantage was the exposure of the joists. This is remedied partly by covering those below, which is of unmixed advantage, and partly by separating the joists widely, which increases weight, depth, and thrust, and is therefore partly disadvantageous. Hollow arches decrease the weight, and flat arches the depth, but the latter increase the thrust, and tie rods to counteract this have great disadvantages. Hollow flat arches are built on two systems, the end pressure system and the side pressure; the former is the stronger, and has the merit of encasing tie rods, but has disadvantages of erection in practice. Side pressure arches are not so strong, but are preferred generally on account of their hollows being parallel to the joists. A great requisite for economy is uniformity of section in the blocks, so that they may be made by being squeezed through dies. In America the side and end pressure systems have been combined. Flat floors are stronger than requisite when in solid slabs, and when hollow in double slabs are otherwise inconvenient. Thin slabs strengthened with metal and supported on joists far apart, and separately cased, have been largely used. Tubular lintel floors have many advantages, being light and strong, and protecting inferior concrete laid over them. They are also far more sound-proof than solid floors, a great desideratum. But they also have some practical disadvantages. Small arched floors get rid of some of these disadvantages, while preserving the main merits of the transverse tubular floor.

LAUNCHES AND TRIAL TRIPS.

SANDSEND, steel screw steamer; built by, Wm. Gray and Co., Limited; to the order of, the Pyman Steamship Company, Limited; dimensions, 358ft., 49ft. 6in., 28ft. 3in.; engines, triple-expansion, 25½in., 40½in., 67in. by 45in. stroke; constructed by, the builders; trial trip, 29th November; 11½ knots.

KILNSEA, steel screw steamer; built by, Wm. Gray and Co., Limited; to the order of, Wm. Brown, Atkinson and Co., Limited; dimensions, 336ft., 47ft., 24ft. 10in.; engines, triple-expansion, 24in., 38in., 64in., by 42in. stroke; pressure 160 lb.; constructed by, the builders; trial trip, November 30th; 11 knots.

HYSON, cargo steamer; built by, David and Wm. Henderson and Co., Limited; to the order of, the China Mutual Steam Navigation Company, Limited; dimensions, 465ft., 53ft., and 34ft.; to carry, 6600 gross tonnage; trial trip, 29th November; 13½ knots.

ROSALIE, steel spar deck steamer; built by, Northumberland Shipbuilding Company, Limited; to the order of, John Cory and Sons, Limited; dimensions, 370ft., 48ft., 30ft. 10in.; to carry, 7000 tons deadweight; engines, 2000-horse power; constructed by, Wallsend Slipway and Engineering Company; launch, December 4th.

GADSBY; built by, Ropner and Co.; to the order of, R. Ropner and Co.; to carry, 5300 deadweight; engines, triple-expansion, 1300-horse power; constructed by, Blair and Co.; trial trip, November 29th.

BATTENHALL, steel screw steamer, raised quarter-deck type; built by, Blyth Shipbuilding Company, Limited; dimensions, 259ft. long; constructed by, MacColl and Pollock; launch, December 5th.

It has been stated that the French *attaché* at Washington intends to recommend his Government to spend part of their appropriations for submarine vessels in buying or building a Holland model. It is said that France is negotiating for the purchase of several submarine vessels, and for the exclusive use of patents respecting them.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

23rd November, 1899.

23,344. DISPLAYING ADVERTISEMENTS, A. Cruickshank, London.
23,345. DISPLAYING ADVERTISEMENTS, A. Cruickshank, London.
23,346. TURNIP THINNER, J. Richmond, Bridge-of-Earn, N.B.
23,347. MATTRESSES, L. Smith and W. Cliffe, Heckmondwike.
23,348. GRABS and EXCAVATORS, E. G. Fiegehen, Bedford.
23,349. CARRYING of TRICYCLES, H. Potter, Bexley, Kent.
23,350 MACHINES for WRINGING CLOTHES, S. Barratt, Leicester
23,351. PHOTOGRAPHIC SHUTTERS, W. O. Stanley, Dublin.
23,352. VELOCIPEDES, R. and J. Burns, Coventry.
23,353. OPENING CLOSED ENVELOPES, &c., W. Lawson, Burnley.
23,354. AUTOMATIC AIR-PRESSURE ALARM, J. H. Silley, London.
23,355. PUMPING MACHINERY, A. Kesson, Glasgow.
23,356. LAMINATED LEATHER BELTS, J. Hendry, Glasgow.
23,357. COMBINED SOAP-BOX and CUTTING APPLIANCE, W. A. Brown, Manchester.
23,358. HUMANE LIFE SNAP TACKLE for FISHING, W. Turner, Blackpool.
23,359. BRAKE for VELOCIPEDES, H. E. Jones and W. Manning, Birmingham.
23,360. CONCENTRATED EXTRACT, Montgomerie and Co., Limited, and J. Montgomerie, Glasgow.
23,361. BREAD, &c., Montgomerie and Co., Limited, and J. Montgomerie, Glasgow.
23,362. WASHING and COOKING BOILERS, A. Airey, Darwen, Lancs.
23,363. METAL FERRULES, R. Penlington and J. Taylor, Manchester.
23,364. LOOKING-GLASS MOVEMENTS, J. Jewsbury, Birmingham.
23,365. STEAM GENERATOR SHELLS, B. F. McTear, Liverpool.
23,366. HANDLES of PERAMBULATORS, G. A. Edman, Birmingham.
23,367. SHEET METAL CANDLE-STICKS, R. H. Hepburn, Birmingham.
23,368. FIRE-BARS, H. Garland, J. J. Warry, and A. H. Stevenson, Liverpool.
23,369. ATTACHMENT to GAS BRACKETS, C. T. Menke, Birmingham.
23,370. METALLIC PACKINGS, T. Matthews and R. Howcroft, Manchester.
23 371. SWITCHES, R. A. Sloan and J. E. L. Barnes Liverpool.
23 372. SPRING FORKS and STAYS for CYCLES, T. Price, London.
23,373. TEA and COFFEE POTS, C. H. Burgess, Manchester.
23 374. ROLLERS for MACHINES, B. and D. Wright, Leeds.
23,375. SAFETY RAZOR, H. Birkbeck.—(*F., R., and O. Kampfe, United States.*)
23,376. BOX for SAFETY RAZOR, H. Birkbeck.—(*F., R., and O. Kampfe, United States.*)
23,377. STAKING, &c., LEATHER, B. and D. Wright, Leeds.
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23,393. MILK CAN, R. Durand, Kingston-on-Thames.
23,394. ADVERTISEMENT APPARATUS, W. Gilbert, London.
23,395. MAKING BOOTS, A. G. Brookes.—(*J. A. Hill, United States.*)
23,396. PRODUCING INDIGO-WHITE COMPOUNDS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
23,397. GEAR for TORPEDOES, A. J. van Stockum, London.
23,398. APPARATUS for LIGHTING GAS, W. T. Sugg, London.
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23,402. STRAIGHT BAR KNITTING MACHINE, J. Walker, London.
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23,418. MANTLES for INCANDESCENT BURNERS, J. Wagner, London.
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23,423. SHUTTLES for LOOMS, P. M. Schiersand, London.
23,424. REMOVING BOBBINS from LOOMS, P. M. Schiersand, London.
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23,426. GAS COMPRESSING APPARATUS, A. Scholl, London.
23,427. PREPARATION of a NEW MEDICINE, E. Edwards. —(*W. Schulz, Germany.*)
23.428. CRUSHING MACHINES, R. A. Hadfield and A. M. Jack, London.
23,429. MANUFACTURE of WHEELS, H. Campbell, London.

24th November, 1899.

23,430. SHIPBUILDING, J. Brown, Donaghmore, Co. Tyrone.
23,431. TURRET LATHE TOOL HOLDER, D. Fleming, Herefordshire.
23,432. ACETYLENE GAS GENERATORS, A. L. Kieny, London.
23,433. STOPPERS for BOTTLES, J. and J. H. Whatmough, London.
23,434. REVERSING GEAR for ENGINES, J. Patterson, Belfast.
23,435. ELECTRICAL CONTACT MAKERS, J. W. Milligan and F. Oldfield, Birmingham.
23,436. MACHINES for IRONING LINEN, F. J. Hill, Leicester.
23,437. VALVE for PNEUMATIC TIRES, M. Pedersen, Dursley, Glos.
23.438. LIDS and KNOBS of JUGS, A. Martin, Birmingham.
23,439. HORSESHOE, W. Freeman and D. Sinclair, Coventry.
23,440. ELECTRIC LAMPS, H. G. Mason, London.
23,441 CARVING KNIVES, W. Hibbert, Manchester.
23,442. EXPLOSIVES, J. Ross and W. D. Cairney, Glasgow.
23,443. BRAKE for ELECTRIC CIRCUITS, P. C. McFarlane, Glasgow.
23,444. FIRE ESCAPES and SCAFFOLD HOLDERS, C. E. Ely, Glasgow.
23,445. SMALL-ARMS, J. Carter and H. Bruntnell, Birmingham.
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23,451. WINDOW SASHES, J. J. Harley, Liverpool.
23,452. NOTCH for UMBRELLAS, J. B. Leatherbarrow and T. B. Margetts, Manchester.
23,453. GEAR for SHAFT COUPLINGS, C. Van Gyn, Glasgow.
23,454. BOXES, L. F. Ferrell, Glasgow.
23,455. STOVES, M. T. Lander, London.
23,456. LIFT or LOADING PLATFORM, W. T. Rounsivell, London.
23,457. ALBUMS for ADVERTISING, M. Bonnamour, London.
23,458 FIRE-PROOF CEILINGS, M. Münch-Phipps, London.
23,459. INSULATING COVERINGS for PIPES, J. Kessel, London.
23,460. MARKING SIDES of CYCLE SADDLES, E. Lycett, Birmingham.
23,461. DIES for MAKING CYCLE SADDLES, E. Lycett, Birmingham.
23,462. PREVENTING VEHICLE ACCIDENTS, T. Bramwell, London.
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23,464 AMMUNITION POUCHES, A. J. R. Purchell, London.
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23,467. RETORTS for HEATING SUBSTANCES, J. Lyle, London.
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23,486. PREPAYMENT GAS METERS, Frank Wright's Prepayment Gas Meter Corporation, Limited, and J. D. Forster, London.
23,487. HOSPITAL BEDS, H. L. Piper, London.
23,488 IMPROVING the PRINTING SURFACES of PAPER, A. J. and F. C. A. Adams, and W. B. Beckley, London.
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23 491. DISTRIBUTING MANURE, A. J. Boult.—(*A. Billiard, France.*)
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23,497. PHONOGRAPHS, F. von Madaler, London.
23,498. EXPANSIBLE PLUG for SHOT HOLES, J. Bovier, London.
23,499. FINISHING BALLS of THREAD, W. L. Wise.—(*The firms J. Sabsmann-Daniker and Nufer and Co., Switzerland.*)
23,500. COUPLING for RAILWAY VEHICLES, S. Geoghegan, London.
23,501. VACUUM TUBE LIGHTING, W. L. Wise.—(*The Moore Electrical Company, United States.*)
23,502. APPARATUS for RAISING WATER, E. P. Jenner, London.
23,503. POLISHING PLATE GLASS, M. R. Welty and G. S. Rumbaugh, London.
23,504. RECEIVING APPARATUS for HERTZIAN RADIATIONS, J. C. Baviera, London.

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23,505. GAS STOVES, S. Chandler, jun., and J. Chandler, London.
23,506. SADDLE for CYCLES, F. W. Barratt, Wimborne, Dorset.
23,507. MEASURING LIVING ANIMALS, W. H. Duncan, London.
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23,509. BOOKBINDING, C. and G. B. Taylor, Birmingdam.
23,510. STAIRCASES, E. Wood and Co., Ltd., and H. R. Butler, Manchester.
23,511. WRINGERS, J., W. U., and J. R. U. Morton, Glasgow.
23,512. SHUTTLES for WIRE WEFTS, C. Harris and J. Bradbury, Manchester.
23,513. ADVERTISING APPARATUS, J. E. Bennett, Manchester.
23,514. CRAB WINCHES, W. T. Eades and E. Allday, Birmingham.
23,515. PHOTOGRAPHIC CAMERAS, S. D. McKellen, Manchester.
23,516. GAS STOVES, P. N. Orr, Sheffield.
23,517. PEDAL PINS, T. Cairns, Birkenhead.
23,518. SEWING MACHINES, M. H. Pearson, Leicester.
23,519. LOCK NUTS for BOLTS, B. J. Maloney, Edinburgh.
23,520. AUTOMATIC BRAKE, W. H. Butlin, Stonehouse, Glos.
23,521. BRAZELESS-JOINTED CYCLE, W. H. Butlin, Stonehouse, Glos.
23,522. ELECTRIC CUT-OUT, E. C. St. John, London.
23,523. BRIDLE FITTINGS, E. R. Wethered, London.
23,524. CONDENSING LIQUIDS for AIR, E. A. Le Seur, Ontario, Canada.
23,525. WEATHER BAND for DOORS, H. Russell, Bexhill, Sussex.
23,526. RAILWAY BUFFER, W. D. Muncaster, Carlisle.
23,527. EMULSION-MAKING APPARATUS, G. J. Blore, Manchester.
23,528. CUTTING PHOTOGRAPHIC PRINTS, J. Davenport, London.
23,529. DRIVING BANDS for PROJECTILES for QUICK-FIRING, &c., GUNS, T. R. and T. A. Bayliss, Birmingham.
23,530. SECURING WIRE MATTRESSES, D. D. Forbes, Glasgow.
23,531. A TOY RELATING to PALMISTRY, R. K. Sillars, Glasgow.
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23,541. ELECTRIC IGNITION DEVICE, H. J. Lawson, London.
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23,544. BOTTLE STOPPER, J. Forshaw, junior, Liverpool.
23,545. MILLS for GRINDING GRAIN, W. O. Bailey, London.
23 546. SHIELDS, T. O. Curtiss, junior, and J. A. Knox, London.
23,547. INSTEP FASTENER for BOOTS, A. Brammer, Leeds.
23,548. SHED, G. Ehrhardt, London.
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23,550. PENHOLDER, J. P. Steinbach and K. H. Strache, London.
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23,554. DEVICE for DRESSING CURRANTS, J. G. Gibson, Liverpool.
23,555. BOXES for HOLDING CIGARS, G. Bingel, Birmingham.
23,556. BRAKES for ROAD VEHICLES, A. L. Lovick, London.
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23,558. VALVES for PNEUMATIC TIRES, E. F. Declercq, London
23,559. UNDERGARMENT for LADIES, H. Cecile, London.
23,560. PENS, A. M. Clark.—(*B. F. Marsh, United States, and another.*)
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23,562. SMOKE CONSUMERS, J. Ormerod, London.
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23,569. SUPPORTING BURNERS, Sir W. G. Armstrong, Whitworth, and Co., Limited, and E. L. Orde, London.
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23,581. NON-REFILLABLE BOTTLES, A. E. Lee, London.
23,582. REGULATING GAS PRESSURES, R. T. and J. G. Glover, London.
23,583. PRESERVATION of WOOD, J. G. Pauchon, London.
23,584. CONNECTING STONE ARTICLES, W. F. Loffelhardt, London.
23,585. TARGETS, H. H. Lake.—(*E. E. Thresher, United States.*)
23,586. INK-WELL CASES, W. H. Barten, London.
23,587. ELASTIC TIRES for VEHICLES, A. Ducasble, London.
23,588. SEWING MACHINES, W. L. Wise.—(*The Fabrik für Spezialnähmaschinen A.G. [Patente, J. Gutmann], Switzerland.*)
23,589. WHEEL-DRIVING MECHANISM, P. C. Henriksen, London.
23,590. SELF-CLOSING DOORS, T. and J Kelly, Edinburgh.

27th November, 1899.

23,591. COUPLING APPARATUS for VEHICLES, H. Medway, Southampton.
23,592. BRAKES for VEHICLES, T. A. Hearson, Englefield Green, Surrey.
23,593. BLUE-GREEN DYE-STUFFS, R. J. Urquhart.—

(*The Chemische Fabriken vormals Weiler-ter-Meer, Germany.*)
23,594. EXTINGUISHING DEVICE for LAMPS, M. Ferguson, Wark-on-Tyne.
23,595. EGG WHISK, M. Holdsworth and H. Wallace, Bradford.
23,596. HAND BRAKE for WAGONS, J. F. Lewis, Leytonstone, Essex.
23,597. EMULSIFYING MACHINES, S. Griffin, Bath.
23,598. CONCENTRATING SACCHARINE, J. and C. McNeil, Govan, Lanarkshire.
23,599. HAND BRAKES, W. S. Laycock, Sheffield.
23,600. PASSENGER COMMUNICATION INDICATOR, A. G. Wild, Sheffield.
23,601. BRAKES for CYCLES, W. T. Fisher and J. Nixon, Coventry.
23,602. CHIMNEY COWLS, J. H. Bonehill, Birmingham.
23,603. MANUFACTURING WATERPROOF MATERIAL, W. J. Ward, Manchester.
23,604. LOOM BOXES, W. B. White and Sons, Limited, W. B. White, and A. Jack, Burnley.
23,605. FLYING MACHINE or AIR SHIP, J. Jones, Dundee.
23,606. FRUIT CASE, J. B. Le Page, Guernsey.
23,607. MACHINES for WEAVING WIRE, J. Stally, Birmingham.
23,608. WHEELS for VELOCIPEDES, W. A. Leadbetter, Birmingham.
23,609. MAKING CORK, H. D. Fitzpatrick.—(*M. A. Hocquet, France.*)
23,610. COMBINED STEPS and CHAIRS, W. W. Boddy, Wolverhampton.
23,611. SCREWING UP PICTURE FRAMES, H. Lawson, Glasgow.
23,612. FLUSHING WATER-CLOSETS, L. H. Lloyd, Derby.
23,613. CONVERTERS for MAKING IRON, J. E. Mitchell, Halifax.
23,614. DISINFECTING WATER in CISTERNS, F. E. Etches, Dundee.
23,615. SCREWS, G. G. Birrell, Glasgow.
23,616. WINDOWS, A. McKinnon, Glasgow.
23,617. TURBINE DYNAMO-PNEUMATIC MOTIVE MACHINE, J. F. M. Riffard, St. Etienne, France.
23,618. OIL SEPARATORS, E. H. Beckett, London.
23,619. INCANDESCENT ELECTRIC LAMP, R. Beese, Berlin.
23,620. COUNTING DEVICE, S. Hartmann and H. König, Berlin.
23,621. ELECTRO-MAGNETIC IGNITION, E. Bolbrinker, Berlin.
23,622. SHAFT, J. Jones, Dundee.
23,623. TAPS, C. Meyer, London.
23,624. GAME, H. McGowan, London.
23,625. ACETYLENE GENERATORS, T. J. and E. J. Perry, London.
23,626. CASES for EXPLOSIVE CHARGES, R. B. Pollitt, London.
23,627. CYLINDERS for PHONOGRAPHS, A. Rosenberg, London.
23,628. MOTORS, S. J. Williamson, Liverpool.
23,629. DEVICES for GOVERNING PRESSURE, T. R. Shillito.—(*The "Phönix" Maschinenbaugesellschaft, Germany.*)
23,630. SADDLES, A. Churchward, London.
23,631. PNEUMATIC TIRES for CYCLES, J. H. F. Carstens, Berlin.
23,632. PRODUCTION of MOTIVE POWER, N. J. A. Boex, London.
23,633. CHURNS, L. A. Aspinwall, London.
23,634. ANTISEPTIC FLUIDS, J. B. de Alzugaray, London.
23,635. COUPLING RAILWAY WAGONS, T. H. Cartwright, Birmingham.
23,636. COUPLING RAILWAY WAGONS, T. H. Cartwright, Birmingham.
23,637. PRODUCING DYESTUFFS, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
23,638. FRAMES for ROAD VEHICLES, P. M. Justice.—(*Columbia and Electric Vehicle Company, United States.*)
23,639. SALES BOOKS, R. Clark, London.
23,640. CASTING PHOTOGRAPHIC PLASTER, M. Bernstein, Berlin.
23,641. REGENERATING CARBONATE of BARYTA, B. J. B. Mills.—(*L. Michaud, France.*)
23,642. FOG SIGNALS for RAILWAYS, F. Buckland, Thornton Heath, Surrey.
23,643. FRICTION CLUTCHES for FREE-WHEEL CYCLES, W. G. Little, Bexley, Kent.
23,644. OBTAINING POWER, G., F. M., and A. James, London.
23,645. CHECKS, F. Heinz, Liverpool.
23,646. DRIVING the SHUTTLES of LOOMS, C. Herold, Manchester.
23,647. EXPLODING FOG SIGNALS, E. and L. Magnin, London.
23,648. TOOTH BRUSH, R. Haddan.—(*W. Stark, Austria-Hungary.*)
23,649. PENCIL HOLDERS, D. Kinzinger, London.
23,650. EXCHANGING POSTAL MATTER with TRAINS, W. Wenström, London.
23,651. BOXES for COINS and MATCHES, H. Ruben, London.
23,652. EXPLOSION MOTORS, C. Fessard, London.
23,653. SPRINGS, E. Sandow, London.
23,654. DELIVERING LIQUID, M. Schröter and I. C. Praszkier, London.
23,655. DRYING PAPER, J. C. Mewburn.—(*Radebeuler Maschinenfabrik August Koebig, Germany.*)
23,656. SUSPENDING CLOTHES, J. W. Mackenzie.—(*J. O. Attaque and A. Almqvist, Sweden.*)
23,657. PRODUCING INDAZOL, R. B. Ransford.—(*L. Cassella and Co., Germany.*)
23,658. CAR-COUPLING APPARATUS, W. McConway, London.
23,659. ELASTIC WHEEL SPOKES, E. F. M. Le Janne, London.
23,660. DEVISING SURFACE of PAPER, E. W. Smith, London.
23,661. PHYSICAL EXERCISE APPARATUS, E. H. Miles, London.
23,662. SHUT-OFF VALVE APPARATUS, H. Stauff, London.
23,663. ARMATURE for ALTERNATING-CURRENT MOTORS, J. Burke, London.
23,664. OBTAINING METAL SULPHATES, O. Meurer, London.
23,665. WORKING ENGINES, O. Imray.—(*H. Homberger, Germany.*)
23,666. PIPE, K. Holm, London.
23,667. BRICK MACHINES, L. H. Rittmann.—(*E. de S. Hubert, Belgium.*)
23,668. RAIL-CONNECTING DEVICES, &c., J. Bause, London.
23,669. SPEED GEAR, A. J. Boult.—(*J. Wertheimer and A. Levasseur, ——.*)

28th November, 1899.

23,670. FIXING VALVES to PUMPS, W. Robins, Dartford, Kent.
23,671. TOBACCO PIPE, D. W. Glendinning, London.
23,672. MACHINE for SHUFFLING CARDS, J. Robinson, Ipswich.
23,673. PUMPING MACHINERY, W. H. Booth, London.
23,674. LOCKS and KEYS, H. T. Davidge, Lee-on-the-Solent, Hants.
23,675. BORING MACHINE STANDARDS for ROCK, C. Walton, Heeley, near Sheffield.
23,676. WARP MERCERISING MACHINE, J. M. Collins, Glasgow.
23,677. PUMPS, H. Bowman and J. T. Southworth, Manchester.
23,678. RECOVERING TIN from TIN SCRAP, T. Twynam, Egham.
23,679. EXHIBITING MOVING PICTURES, G. Hollingam, New Barnet.
23,680. JUGS, &c., A. Smith, Birmingham.
23,681. CONCENTRATING APPARATUS, J. Foster, Glasgow.
23,682. WATER METERS, A. G. Browning, Sutton, Surrey.
23,683. EMULSION for DOGS and PHEASANTS, C. Sanderson, Glasgow.
23,684. COUPLINGS for RAILWAY WAGONS, G. and J. H. Gowling, and J. McGeachy, Glasgow.
23,685. EXHIBITING COLOUR PHOTOGRAPHS, W. White, London.
23,686. CUSPIDORES, T. Lees, London.
23,687. MACHINES for DRAWING CORKS, T. Lees, Glasgow.
23,688. PUZZLE, E. G. Wippell, Birmingham.
23,689. DRYING ROOFING TILES, &c., L. Nefkens, Liverpool.
23,690. SPRAYING APPARATUS, R. W. Rice, Liverpool.
23,691. TRAMWAY RAIL JOINTS, J. S. Holme, Egremont, nr. Liverpool.
23,692. ATTACHING INFLATORS to CYCLES, C. E. Skinner, Manchester.
23,693. FLY PAPERS, J. H. Mackay, Reading.
23,694. SURFACE HEATERS or CONDENSERS, J. Wright, London.
23,695. MERCERISING COTTON YARNS, E. Price, London.
23,696. ELECTRIC ALARM SYSTEMS for PROTECTING BUILDINGS, A. G. Brookes.—(*E. F. Woodman and H. A. Fiske, United States.*)
23,697. VISIBLE and AUDIBLE SIGNALS, R. M. Dixon, London.
23,698. DISPOSITION of MOTORS in CYCLES, J. Weller, London.
23,699. BOTTLE NECKS and STOPPERS, R. C. Watkins, London.
23,700. VALVES for STEAM ENGINES, J. and J. R. Temperley, London.
23,701. SKIRT and BLOUSE BAND HOLDER, G. C. Hall, London.
23,702. ROUND FRAMES for KNITTING, C. Axamitt, London.
23,703. CAN-HEADING MACHINE, C. A. Allison.—(*M. Ams, United States.*)
23,704. PLEASURE RAILWAYS, H. Funk and K. Tschipke, London.
23,705. TOY FLAG PUZZLE, T. J. Hammersley and T. Flatman, London.
23,706. OUTDOOR SEATS, G. Pullan, London.
23,707. BALANCED ROTARY STEAM ENGINES, B. Ljungström, London.
23,708. HARNESS SADDLES, W. O. Campbell and W. H. Mickey, Kingston-on-Thames.
23,709. WIND MOTORS, J. R. Emery, Kingston-on-Thames.
23,710. WAGONS, J. Wilson, Kingston-on-Thames.
23,711. CHANGING INDICATORS, J. D. F. Andrews, London.
23,712. SCREW-THREADING MACHINERY, H. P. Ellers, London.
23,713. ELECTRICALLY-ILLUMINATED ADVERTISEMENTS, H. Tripp, G. E. Stephenson, and W. C. C. Lartz, London.
22,714. JACKS, F. Schulz, London.
23,715. BOX-MAKING APPARATUS, W. H. Butler, London.
23,716. BOOT-MAKING MACHINES, H. H. Lake.—(*A. E. Johnson, United States.*)
23,717. GRINDING or CRUSHING MILLS, R. Baumann, London.
23,718. MATCHES, H. H. Lake.—(*G. A. Barnes, United States.*)
23,719. BOXES, H. H. Lake.—(*G. A. Barnes, United States.*)
23,720. FLUID-PRESSURE BRAKES, H. O. Müller, London.
23,721. DECANTING LIQUIDS, G. G. M. Hardingham.—(*A. Musciacco, Italy.*)
23,722. TYPE-SETTING MACHINES, &c., The Dow Composing Machine Company and A. Dow, London.
23,723. GAS-BURNER APPARATUS, G. Strunk, Barmen, Germany.
23,724. GASIFYING PETROLEUM, A. J. Boult.—(*C. de Haupt, Belgium.*)
23,725. SPACE LINES for TYPE-SETTING, J. G. Paine, London.
23,726. HOLDERS for PLAYING CARDS, G. Prechtl, London.
23,727. SMOKING PIPES, C. Haindl, London.
23,728. MANUFACTURE of LEAD PLATES, M. Wuillot, London.
23,729. PRODUCTION of TEXTILE FIBRES, P. A. Newton.—(*C. A. Granquist, Sweden.*)
23,730. APPARATUS for BORING at GREAT DEPTHS, J. Vogt, London.
23,731. GENERATION of ACETYLENE GAS, G. H. Quelch and T. O. Kent, London.
23,732. GAS VALVES, J. Murphy and H. L. Arnold, London.
23,733. GEAR CHAINS, D. H. Macpherson and E. W. Rudd, Birmingham.
23,734. ELECTRIC LIGHTING APPARATUS, J. Bouillet, London.
23,735. MAKING PRINTING PLATES, J. S. Duncan, London.
23,736. SOFA BEDS, H. J. Haddan.—(*W. T. Rolph, United States.*)
23,737. CONTACT SHOES, The British Thomson-Houston Company, Limited.—(*S. H. Libby, United States.*)
23,738. COMPOUNDING ELECTRIC ALTERNATORS, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
23,739. ELECTRIC RAILWAY CARS, The British Thomson-Houston Company, Limited.—(*W. B. Potter, United States.*)
23,740. CONTROLLING ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
23,741. PRODUCTION of BOILER PIPES, O. Klatte, London.
23,742. MAGIC-LANTERNS, D. A. Lowthime, London.
23,743. FRICTIONAL DRIVING MECHANISM, R. E. Phillips.—(*A. H. Overman, United States.*)
23,744. INTERNAL COMBUSTION ENGINES, C. G. Borthwick, London.
23,745. CUSHIONS, T. Banks, Liverpool.
23,746. BOTTLE BOXES, J. I. Tinkler, Liverpool.
23,747. SALVAGE BOXES, F. W. Jurgechat, Manchester.
23,748. COIN-FREED TOYS, G. D. Palmer and H. Hartley, Birmingham.
23,749. CARDBOARD BOXES, A. M. Davis and G. Bingel, Birmingham.
23,750. OBTAINING REPRODUCTIONS of MAPS, G. Clulow, London.
23,751. ROTARY ENGINE, J. H. Darragh, London.
23,752. STIFFENINGS for BODICES, A. vern. Laska, London.
23,753. ELECTRIC CURRENT INDICATOR, E. C. Rimington, London.
23,754. LAMP CHIMNEYS, T. L. Mitchelmore, London.
23,755. ELECTROLYTIC APPARATUS, J. D. Darling and C. L. Harrison, London.
23,756. COOLING AIR, H. H. Lake.—(*A. T. Perkins and F. C. Weber, United States.*)
23,757. HOLDERS for PLAYING-CARDS, F. P. Fritzsche, London.
23,758. PRODUCING ACETYLENE GAS, P. O. Petterson, London.
23,759. TURBINE MOTORS, N. Nilsson, London.
23,760. NUT LOCK, C. F. de Redon, London.
23,761. ROLLERS for COTTON GINS, T. H. Pearse, London.
23,762. GLOVES, R. Warner, jun., London.
23,763. TROUSER PRESSES, R. H. Bishop, London.
23,764. STRINGED MUSICAL INSTRUMENTS, H. H. Lake.—(*J. R. Maynadier, United States.*)
23,765. APPARATUS for COMPRESSING AIR, E. Gobbe, London.
23,766. KILNS, E. Gobbe, London.
23,767. IGNITING ARRANGEMENTS, W. Dederich.—(*Heinle and Wegelin, Germany.*)
23,768. LETTER FILES, G. Castleden, London.
23,769. MAKING TEA, G. Castleden, London.
23,770. VALVES for GAS BURNERS, E. D. Burkitt, London.
23,771. GAS GOVERNORS, S. Chandler, jun., and J. Chandler, London.

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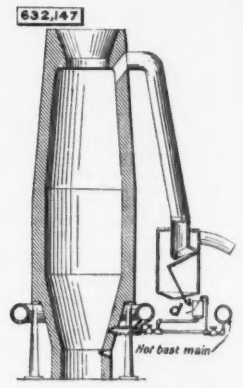
23,772. SMOKE PREVENTER, J. Balmforth, Oldham.
23,773. MOTOR-DRIVEN ROAD VEHICLES, E. Gascoine, London.
23,774. CHEQUER BRICK, J. Place and Sons, Limited, and W. H. Place, Halifax.
23,775. BRAKE, C. M. M. Berthe, Coventry.
23,776. SMOKE CONSUMER for LAMPS, H. Rowlands, Birmingham.
23,777. PACKING STAVES into BUNDLES, A. Dunbar, Liverpool.
23,778. BEER ENGINES, A. Austin and E. Dry, London.
23,779. COLLAPSIBLE ROWING CRUTCH, G. H. Attrill, London.
23,780. APPLIANCES for HANGING PICTURES, T. Herbert, Glasgow.
23,781. TROLLEY HEADS for ELECTRIC TRAM CARS, L. B. Powderly, Dublin.
23,782. DIAMOND SAWS for CUTTING STONE, J. T. Pearson, Burnley.
23,783. MANUFACTURE of METALLIC OXIDES, J. Hargreaves, Farnsworth-in-Widnes, Lancs.
23,784. SELF-ACTING MULES, W. G. Heys.—(*A. Hirle, France.*)
23,785. MANUFACTURE of WHEELS, W. Malam, Manchester.
23,786. SETTING DIAMONDS in CUTTING TOOLS, J. Corrigan, Manchester.
23,787. PUNCTURE PREVENTER for TIRES, L. L. Goodman, Manchester.
23,788. "CHAIN-STITCH" SEWING MACHINES, A. Birch, Manchester.
23,789. PIECING-UP WARPS, J. Eccles and E. Ainsworth, Manchester.
23,790. ROOFS, W. and W. D. Richardson, Stockton-on-Tees.
23,791. BOTTLES to CONTAIN PEPPER, &c., A. Clark, London.
23,792. SAFETY ATTACHMENT for CYCLES, G. T. Jones, Llwynpia, Glam.
23,793. STEAM BOILERS, E. W. Wynne, Liverpool.
23,794. LOCKS, The Co-operative Padlock Society, Limited, and E. Lawton, Wolverhampton.
23,795. STORAGE TRAYS for FRUIT, E. W. Hearn, Wisbech.
23,796. GAS BURNER, T. P. Moorwood and F. C. Jessop, Sheffield.
23,797. ACETYLENE GAS GENERATOR, Bon-Accord Acetylene Gas Company, B. R. Chicken, and A. G. Smith, Aberdeen.
23,798. VEHICLES, W. S. Foster, London.
23,799. "PRINCESS ENAMEL," G. L. and C. A. Critchley, and J. J. Davies, St. Helens, Lancs.
23,800. COLLAPSIBLE BEDSTEADS, T. W. H. Biddle, London.
23,801. FIXING PARASOL RIBS to STICKS, W. Davison, London.
23,802. CHAIRS, C. J. Pinnell, London.
23,803. BED-TRAY for HOSPITAL USE, E. G. Townsend, London.
23,804. ARGAND GAS BURNERS, W. G. Potter, Birmingham.
23,805. RAILWAY CARRIAGE LAMPS, W. G. Potter, Birmingham.
23,806. BAYONETS and LANCES, W. G. Potter, Birmingham.
23,807. COTTON FABRIC, J. W. E. Dick, London.
23,808. PRODUCTION of TOBACCO, F. W. Haase, L. Broeckmann, and C. Haase, London.
23,809. STOPPERS for EARTHENWARE PIPES, R. Ewing, London.
23,810. ATTACHING BODICE and SKIRT BANDS, A. E. Sallaway, London.
23,811. STOOLS, J. W. Lea and J. H. Perrins, London.
23,812. COIN-CONTROLLED MECHANISM, A. E. Phare, London.
23,813. GALVANIC BATTERIES, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany.*)
23,814. AIR TURBINES, C. F. de Kierzkowski-Steuart, London.
23,815. COIN-RECEIVING APPARATUS, F. Humphries and G. H. Forster, London.
23,816. ORE CRUSHERS, E. D. Chester and E. Chester and Co., Limited, London.
23,817. METALLIC BEDSTEADS and COTS, G. A. Phillips, Birmingham.
23,818. PRINTING MACHINES, F. Meisel, London.
23,819. CUES, H. V. Beaufils, London.
23,820. WATER-CLOSETS, H. L. Doulton, London.
23,821. COVERS for TIRES of CYCLES, J. A. Taylor, London.
23,822. STRETCHING FABRICS, B. J. B. Mills.—(*J. Thollon, France.*)
23,823. FACING BLOCKS for BUILDINGS, J. T. South, London.
23,824. SIPHON VESSEL for BEER, A. Heinemann, London.
23,825. SHAFT GOVERNORS for MOTIVE POWER ENGINES, W. Reavell, E. B. Ball, and Reavell and Co., Limited, London.
23,826. REPRODUCING on MATERIALS FACSIMILES of ORIGINALS, T. Truchelut and A. A. Rochereau, London.
23,827. HYDROXY-ALDEHYDES, G. B. Ellis.—(*La Société Chimique des Usines du Rhône anciennement Gilliard P. Monnet et Cartier, France.*)
23,828. STERILISING LIQUIDS, J. Y. Johnson.—(*The Compagnie Générale pour la Conservation des Liquides, France.*)
23,829. GENERATING ELECTRIC CURRENTS, G. Koppelmann, London.
23,830. CARBONS for CHEMICAL PURPOSES, E. Pohl, London.
23,831. LAMPS for GIVING INTENSE LIGHT, P. R. de F. D'Humy, Liverpool.
23,832. HEAD-LOCKS for CYCLES, F. W. Dauber, Liverpool.
23,833. WRAPPING CUBED YARNS, J. G. Munro, Manchester.
23,834. TELEGRAPHIC APPARATUS, A. C. Crehore and G. O. Squier, London.
23,835 CULTIVATION of PLANTS, A. J. M. V. Stichaelen, London.
23,836. PICTURE FRAMES, &c., The British Charrier Wood Carving Company, Limited, and A. Oatley, London.
23,837. CONVERTIBLE BILLIARD TABLE, E. S. Doré, London.
23,838. RIM BRAKES for CYCLES, E. and H. Dellit, London.
23,839. ACTUATING a FREE-WHEEL BRAKE, J. Parsley, London.
23,840. SIGNALLING RAILWAY TRAINS, P. Roniche, London.
23,841. DEVICES for CATCHING INSECTS, F. Hahn, London.
23,842. SOAPS, J. F. Phillips, London.
23,843. SAUCEPANS, J. C. Rackham, London.
23,844. PRINTING MACHINES, W. E. Evans.—(*The Campbell Printing Press and Manufacturing Company, United States.*)
23,845. SAWING HARD SUBSTANCES, F. Fromholt, London.
23,846. CONVERTING BICYCLES, P. Abraham and F. M. B. Bertram, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

632,147. BLAST FURNACE, *C. S. Robinson, Sharpsville, Pa.—Filed June 25th, 1898.*

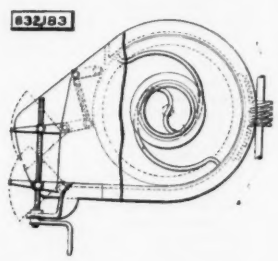
Claim.—(1) In combination with a furnace, a flue dust chamber or collector connected therewith, a supplemental chamber connected with the main chamber to receive dust therefrom, means for applying pressure to the top of said supplemental chamber, an injector discharging into the furnace, a source of pressure connected therewith, and a pipe between the injector and the supplemental chamber, substantially as described. (2) In combination with a furnace, a flue leading therefrom, a dust-collecting chamber connecting with the said flue, means for separating the dust and air within the collecting chamber, a



supplemental chamber *d* connected with the main chamber to receive dust therefrom, means for applying pressure to the top of chamber *d*, an injector discharging into the furnace and a suction pipe between the injector and chamber *d*, substantially as described.

632,183. APPARATUS for CHARGING MATERIALS into OPEN-HEARTH FURNACES, *A. Jack, Motherwell, Scotland.—Filed May 12th, 1899.*

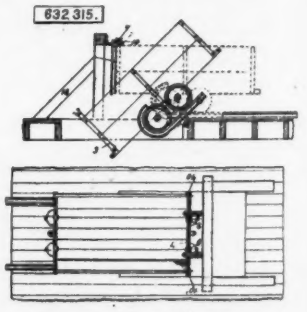
Claim.—(1) Apparatus for charging materials into open-hearth furnaces, and comprising a hollow rotary impeller with a central opening and one or more spiral channels, an inclosing casing therefor having a discharge branch, in combination with a travelling band or conveyor, a motor shaft to drive the impeller



and conveyor, and a carriage on which all said mechanism is mounted, substantially as set forth. (2) Apparatus for charging materials into open-hearth furnaces, and comprising a rotary hollow impeller with a central opening and one or more spiral channels, in combination with an inclosing casing having a discharge branch with adjustable guides and an adjacent yielding part, as and for the purpose set forth.

632,315. DETACHABLE DOOR for DUMPING CARS, *C. P. Ludwig, Woodward, Ala.—Filed June 8th, 1899.*

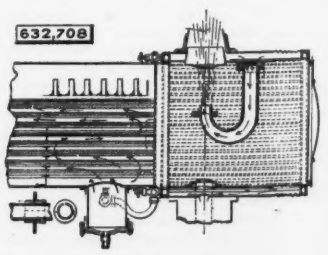
Claim.—A mine or dump car having side iron 3, 3¹, with forked heads formed thereon, a detachable door having a head bar 7 adapted to engage the forked



heads of the side irons, the collars 9, 9¹ and 10, 10¹ formed on the head bar, the plate iron 11 having a pin formed on its lower end to engage the draw bar, and means to suspend the door when the car is dumping, substantially as and for the purpose described.

632,708. FEED-WATER HEATER for STEAM BOILERS, *M. N. Forney, New York, N.Y.—Filed January 3rd, 1899.*

Claim.—In a steam boiler feed-water heater, the combination of an annular heating chamber, a system of heating tubes in said chamber through which feed-



water may be circulated, an exhaust-steam opening leading into said chamber, an exhaust-steam outlet leading out of said chamber, a feed-water supply pipe connected with one end of the heating-tube system, and a feed-water delivery pipe connected with the opposite end of the heating-tube system.

RECENT BRITISH WARSHIPS.

THE coloured supplement which we give this week is itself an example of the development which has taken place in the art of printing, as in most other arts. It is the result of a new process, concerning which more is certain to be heard. It has served well in this instance for placing before our readers examples of the latest work of Sir W. H. White, K.C.B., Chief Constructor and Assistant-Controller of the Navy.

It is a subject for congratulation to find all classes of the community taking a lively interest in matters pertaining to the Navy. Especially is this the case at the present time, when, too, the Navy has reached a magnitude which was not even dreamt of only a few years ago. Occasionally, however, we meet with criticisms of a more or less one-sided character, and comparisons are made between the work done by the officials at Whitehall for our own fleet and that which is done by other nations in respect to their navies. The criticisms we allude to are generally incomplete in character, falling short in the most essential respect, that of pointing out how anything better could be done.

It is not our intention in the present article to criticise the work or views of these critics, but to take three typical modern types in the British fleet, a battleship, a cruiser, and torpedo boat destroyer, and impartially to weigh up the points in which may be said to lie the essential and governing features of these designs.

An impartial observer making a historical survey of the progress of the Navy during the past fifteen or twenty years would be struck perhaps as much by the advance in absolute size of typical ships as by any other feature. This is equally true of battleships and cruisers, and in the following remarks we hope to be able to point out the reasons which, in our opinion, have led to development in this respect. We advert to the question of size, since at any given date this point roughly dominates cost, and hence determines what the British taxpayer must give as the price of his determination to have a navy which shall enable this country to maintain its position as mistress of the seas.

As we were enabled in our issue of November 18th, 1898, to lay before our readers a rough outline of the Formidable, together with a few leading particulars of this ship, we have chosen this vessel as the type of the modern British battleship. To recapitulate briefly, her dimensions are as follows:—Length between perpendiculars, 400ft.; length overall, 430ft.; extreme breadth, 75ft.; draught, when in normal condition of load, 26ft. 9in.; displacement, 15,000 tons. Considering the offensive powers of the ship, we notice that, excepting perhaps a few light guns, the armament is grouped symmetrically at each end of the hull. Taking one end only, say the bow, we have two 12in. guns of the most modern type mounted in a splendidly protected position, and from their height above water and their large arc of uninterrupted training they should render a good account of themselves if needs be. These are flanked by four quick-firing guns of 6in. calibre, which fire a little across the bow to nearly 30 deg. abaft the beam. Then on the broadside the four heavy guns and six of the 6in. quick-firing guns can be brought to bear. The number and disposition of this second part of the main armament has, it is clear, a very marked influence on the dimensions of the ship. In order to avoid interference between the guns they have been placed at considerable distances apart; this in turn has determined the position for the main redoubts, and as it is essential to have these stations well out of the extremities, in order that the seaworthy qualities of the vessel may not be impaired, the length of about 400ft. is seen to be the least that can be accepted.

For the lighter form of attack the 12-pounder quick-firing guns are distributed uniformly throughout the ship, and form a valuable secondary armament in themselves, as not only are they of especial use as a defence against boat attack, but they supply an efficient means for attacking the lighter works of an enemy's ship.

By reference to the plan previously published, it will be seen how judiciously the guns have been placed; and further, that had a much larger number of guns been installed on board, interference of one gun with the fire of others must inevitably have resulted. This is a point of the utmost importance, in our judgment; we need not labour the other disadvantages of more crowded gun-decks, a larger crew, with diminished accommodation for them, &c. After providing an armament, which must be considered excellent, to have each gun placed in such a position that its freedom will be unimpaired by the action of any of the other guns in the ship, and so have its maximum efficiency always attainable, far outweighs the mere glamour of having a larger number of guns, with the certainty that in many cases one gun will be masked by its neighbour, and thus for the time being rendered useless.

Next to the question of guns and their position comes the question of the supply of ammunition, and the means of its convenient transport to the fighting positions. For the big guns this is well provided for by grouping the magazines and shell-rooms vertically between the redoubts, thus arranging for the minimum longitudinal transport of the ammunition. Hydraulic hoists bring both explosive charges and projectiles to the loading positions, which it may be said are independent of the angle of training of the guns, and the rest of the work is easily accomplished.

To minimise labour at the most critical part of an action, a good store of projectiles is carried well up in the redoubts, so that they are within reach without hoisting. The hoist is then entirely devoted to bringing up explosive material, the result being that the officer in charge has the means of accelerating the rapidity of fire to a pronounced degree—a most valuable feature in an engagement. The supply of ammunition to the 6in. quick-firing guns is arranged in a correspondingly thorough fashion. The magazines and shell-rooms open into roomy lobbies from which convenient and wide passages lead directly to positions beneath the rear of each gun; the ammunition is thus brought to the working positions by the most simple and direct transport, all the time being under protection. As with the large guns, a ready supply of shot and shell is arranged for. Should the action be at close quarters four torpedo tubes, all of the submerged pattern, give an opportunity of using this method of offence in the surest way yet known, and with the minimum of risk to the ship herself. At still closer quarters the ram may be used.

When we note the general defensive powers of the ship, we are of the opinion that the arrangements have been thought out in an equally thorough manner. The armour belt is 9in. thick, 15ft. deep, and extends for nearly two-thirds the length of the ship. The material is of the finest quality known. This armour, therefore, worked upon framing of great depth and strength, is so placed as to yield the best possible results in the way of preservation of the ship's stability in action.

At the fore end the side is plated up to the height of the main deck, and down to the point of the ram with special plates 2in. thick, in addition to the ordinary shell plating. Consequently, when chasing an enemy the liability to perforation of the bow by the lighter guns of the foe is very small. This is an important feature, and conduces greatly to keeping up the speed of the chase. The two protective decks form a double roof over the whole vitals of the ship. The upper is the main deck, and is doubtless intended to compel the bursting of the lighter forms of shells, or, indeed, tolerably heavy shells which happen to strike at small angles. The lower armoured deck is of the familiar curved type, and taking position and curvature into account, it forms as complete a protection to the under water portion of the ship as could well be imagined. These features, together with the division of the ship into numerous water-tight compartments, and a careful disposition of the coal, complete the protection of the hull proper.

Turning to the protection of armament, it is clear that the protection of the 12in. guns is as complete as it can possibly be made. Rising from the protective deck are two armoured redoubts of cylindrical form, which completely enclose the turntables and turntable supports. The armour is 12in. thick, and is proof against the attack of the heaviest guns at present built, and over each pair of guns is a roomy armoured hood to protect the gunners. The 6in. guns are each placed in a separate casemate with 6in. armour fronts and 2in. backs. The protection afforded to their crews is by no means small, and the system of isolating each gun in this way ensures practical immunity to the crew from damage from the fire of small guns and from the explosion of comparatively large shell and the scattering *débris* necessarily existent in an action.

We have alluded to the transport of ammunition in our remarks on the armament. We will only repeat that it is brought from the magazines to all the guns of the main armament under cover of the armour, thus altogether avoiding exposed transport of explosive material. As regards speed it is estimated that the vessel will attain a velocity of 18 knots on the measured mile at normal draught. After long experience of the admirable speed performances of the vessels preceding the Formidable, we cannot doubt but that this anticipation will be quite realised. It must be fully understood that when this speed is attained in the trial condition, as it assuredly will be, it implies no guarantee that under all and every condition of service the ship will be propelled at this rate of motion. It does imply, however, that a powerful installation of machinery has been fitted on board which, with proper management, will enable a high continuous speed to be maintained while the coal lasts, and in this respect we have no hesitation in asserting that the Formidable is fully equal to, if not somewhat better than, any battleship at present built which she may ever be expected to meet. In our judgment it is unnecessary to dwell further upon the qualities of the modern British battleship. Much could have been said as to the thoroughness of the equipment in many other respects, the arrangements made for the comfort of the officers and crew, &c., but space forbids.

When we come to consider a typical cruiser, we are face to face with the fact that we can hardly find a type of ship so completely representative of the general body as is the case with the battleship. While, of course, there have been differences in designs of battleships, the battleships within the past ten years built or building, thirty in all, have all ranged within narrow limits of displacement; the Renown being at the lowest point of the scale, with a displacement of 12,350 tons, and the vessels of the Formidable class at the other extreme, each with a displacement of 15,000 tons. A much greater variation in the size of cruisers has been found to be necessary in order that the multifarious duties devolving upon the fleet may be satisfactorily carried out. During the same period as that mentioned above, cruisers have been built ranging in displacement from about 3000 tons up to normal displacements of over 14,000 tons.

When we consider the ever-increasing growth of our mercantile marine, and the increase in average speed of voyage which has been made in recent years, there is not the slightest doubt that the Admiralty has done well in determining to lay down four ships of the Drake class, with a view to the protection of our great maritime routes, and as an answer to the policy pursued by other nations in building commerce destroyers; it being tolerably evident that, excepting ourselves, there is no other country in the world whose commerce is very much worth a serious effort to destroy. From the particulars of the vessel which have been made public from time to time, we think it may fairly be inferred that the key to the design is speed, a high speed under measured mile conditions, and kept up for such a time as will ensure that it is no mere spurt, but that it affords every ground for expectation that a high rate will be maintained for the whole period over which the coal will last. Associated with the question of speed over prolonged periods, is the question of how much the speed is likely to fall off under stress of weather, the large size of these ships and their great height of freeboard, especially forward, make it certain that they will suffer comparatively little in this respect. Coming to particulars, we may say that the dimensions are as follows:—Length between perpendiculars, 500ft.; length overall, 533ft.; breadth extreme, 71ft.; normal draught of water, 26ft. This draught, as in the case of the Formidable, making a passage through the Suez Canal both a certain and easy operation.

We have in general terms already alluded to the matter of speed in this vessel. This point stands out prominently both as a means of offence and of defence. It will enable her to overhaul any vessel in the course of a comparatively short time. When the character of any strange vessel is made out, even should the Drake be under easy steam at the time with a large portion of the boiler power not in use, the water-tube boilers which will be installed will enable steam to be raised in the minimum time, and a chase ought to be a matter of short duration. Her armament is well-balanced. A 9·2in. gun of modern type is mounted on the forecastle, at a commanding height above water, and with a horizontal arc of 270 degrees; a similar gun is placed aft, with the same arc of training. The remainder of the main armament consists of sixteen 6in. quick-firing guns, symmetrically disposed, and of which four can fire right ahead, four right astern, and eight over a large arc of training on each broadside. The remainder of the gun armament is made up of fourteen 12-pounder quick-firing guns, with small boat guns and Maxims in addition. Though an enormous space in the ship must be taken up by machinery and boilers, room has been found for the submerged torpedo tubes.

Equally with the Formidable, the great care with which the armament has been disposed is manifest; each gun has a very large and uninterrupted arc of training. We must not enter into any details regarding the service of ammunition, merely remarking that it is quite as thorough as in the Formidable, and that under these circumstances the gun will be quick-firing in actuality as well as in name.

When we consider the defensive qualities of the ship, it is evident that the most active defence is undoubtedly her speed; she should therefore be able to avoid action with an enemy more powerful than herself. As a means of protection to the hull it is to be noted that an armour belt 6in. thick is worked over about half the length amidships, and extending to the height of the main deck. At the after end of the belt the protection is completed by a transverse armoured bulkhead. Forward, the armour extends to the bow; the thickness is somewhat diminished, but its depth below the water-line is maintained, and the height above water is increased by at least 8ft; thus strongly fortifying the bow against the attack of a retreating foe, and as in the Formidable, minimising the chances of retardation of speed due to perforation of the bows. Two protective decks are worked in accordance with the latest practice.

The protection to the armament next calls for notice. On a cruiser, however large, armour in any quantity is a serious factor in the situation if a high speed is aimed at, and it is no wonder that the designers have found it impracticable to give as much protection to the armament as in the case of the heavier and slower battleship. The heaviest guns, however, come in for a substantial measure of armoured protection, and each 6in. gun is isolated in an armoured casemate with front plates 6in. thick.

The arrangement for the supply of ammunition is of the same general character as that we have already described in the case of the typical battleship.

It is expected that 30,000 indicated horse-power will be developed in the course of the eight hours' official trial with natural draught in the stokeholds. After the successful results on trial of all the recent cruisers and battleships, we cannot doubt but that this enormous power has been fully provided for, and that it will be developed under such circumstances as will make it quite certain that it could easily be realised at any future period in the history of the ship.

So much then for the two principal types of the Navy. If it be urged that they are unnecessarily large for the services expected of them, it is for those who hold such views to point out specifically in which direction improvement may be sought, or what items at present embodied in these designs can be dispensed with without sacrificing efficiency, and while maintaining the small medium of comfort at present preserved to the officers and men. It is certain that the task of the critic is by no means an easy one. The constructive and engineering staff at the Admiralty is fortified in its practice by a mass of experience in the practical performances of the ships which they have turned out in the past, compared with which the experience of the similarly-placed officials of other countries is but small, and against which the opinion of irresponsible and ofttimes ill-informed critics can be safely neglected.

The last type of vessels which claims our attention is the torpedo boat destroyer, and though occasionally we hear doubts expressed as to the wisdom of building vessels of this type, there has been hardly any criticism of the general features of their design.

The genesis of the small but exceedingly fast boat may be said to have commenced with the Miranda, built by Messrs. Thornycroft more than twenty-five years ago. Small as she was she attained a phenomenal speed. Following upon her performance great numbers of lightly-armed swift vessels have been built for our own and for other navies. The smaller types, generally carrying a gun or torpedo armament alternatively, and adapted for keeping the sea for restricted periods only, are called torpedo boats. The larger types carry both gun and torpedo armaments; they can keep the sea for extended periods, and owing to their considerable size it has been found possible to instal

machinery which gives them a decided superiority in speed over the torpedo boat, enables space to be found for a relatively large coal supply, and gives fairly good accommodation for officers and crew; these vessels are called torpedo boat destroyers.

The greater number of these vessels have speeds of about 30 knots. In a few of the latest boats an endeavour has been made to attain somewhat higher speeds without much increase in size, the Albatross being one of this latest type. Her builders are John I. Thornycroft and Co., of Chiswick, and the vessel is rapidly approaching completion. Her dimensions will be found in the accompanying table:—

	Formidable.	Drake.	Albatross.
Length	400ft.	500ft.	227ft.
Breadth	75ft	71ft.	21ft. 3in.
Mean draught	26ft. 9in.	26ft.	8ft.
Displacement	15,000 tons	14,100 tons	400 tons
Horse-power	15,000 (natural draught)	30,000 (natural draught)	7500 (forced draught)
Speed	18 knots	23 knots	32 knots
Coal supply (normal)	900 tons	1250 tons	50 tons
„ (bunkers full)	2000 tons	2500 tons	100 tons
Armament	Four 12in. Twelve 6in. B.L. Eighteen 12-pr. Q F. Fourteen small'r Q F. and machine guns Four torpedo tubes	Two 9·2in. Sixteen 6in. B.L. Fourteen 12-pr. Q.F. Three 3-pr. Q F. Two torpedo tubes	One 12-pr. Q.F. Five 6-pr. Q.F. Two torpedo tubes
Armour	9in. sides 12in. barbette 6in. casemate 2—3in. deck	6—2in. sides 5in. casemates 6in. barbettes	—

Her general appearance will be gathered in sufficient detail from our coloured supplement, and needs no detailed description. The armament consists of one 12-pounder and five 6-pounder guns, all quick-firing, and two revolving torpedo tubes capable of firing the largest pattern service torpedo. The 12-pounder gun is mounted on the conning tower; one 6-pounder is placed on an elevated pedestal on the middle line at the after end of the ship; two 6-pounders are so situated as to be able to fire directly ahead, and the others are on the broadside amidships. All these guns have exceptionally large arcs of training.

The hull structure and fittings are made as light as practicable, consistent, of course, with a due regard to durability; the better to secure this latter point, the greater portion of the material is galvanised, while to obtain the requisite strength with the minimum of weight steel of a specially high grade quality is used. It is in the machinery of this vessel that the most striking evidences of enterprise are manifested. By the adoption of quick-running machinery, and water-tube boilers of the small tube type, it has been possible to develope about 45 indicated horse-power per ton of propelling machinery for short periods.

In order that this performance may be the more thoroughly appreciated, we need only remind our readers that in large ocean-going mercantile steamers with slow-running engines and with cylindrical boilers, only about 6 indicated horse-power per ton of machinery is developed, and in modern large warships with moderately fast-running engines, and with water-tube boilers of the large tube type, about 9 indicated horse-power per ton of machinery is obtained. Of course, these latter figures being based on the power which can be continuously developed, the comparison is not a direct one, but they enable some idea to be formed of the great disparity existing between the installation of machinery of the torpedo boat destroyer and that of large ocean-going steamers.

What we have said about the Albatross applies pretty generally to the torpedo boat destroyers as a class, and it reflects the greatest credit upon the Admiralty and the various builders associated with them in so successfully solving the problems connected with the production of the large fleet of these vessels which this country now possesses.

BRITISH AND AMERICAN MACHINE TOOLS.

No. IV.

THEIR COMPARATIVE COST (*continued*).

It is obvious that the economy which can be effected by the manufacture of large quantities of one or a few articles at a time is considerable, but the full extent of this saving cannot be properly appreciated without visiting a firm which manufactures on this principle, and investigating the methods adopted.

To produce cheaply without sacrificing the quality of the article, considerable outlay on special appliances is necessary. Unless several sets of one machine can be made together, this expenditure is not, of course, permissible, but when repetition is assured the money spent on efficient appliances will more than repay the manufacturer for their initial cost, and in addition to enabling him to turn out his work expeditiously, will result in his producing an article far more accurately finished than if he were to attempt to manufacture a single machine tool with the utmost care on the old lines. The specialists in America have amply proved this, for they have, in some instances, not only succeeded in producing an article less costly than those made by general machine tool makers in their own country, but the excellence of their machines is such that they have compelled their competitors—even the first-class houses—to undersell them in order to retain their trade.

In visiting a factory working on these lines it is not difficult to see how the economy in manufacture is effected. Every machine is fitted with special appliances for dealing expeditiously with repetition work. Planing and shaping machines are equipped with cradles to fit the castings to be dealt with, so that the time in fixing the work is reduced to a minimum. Templates are in use for marking off the work. All small drilling is done with the aid of jigs. In short, after the article to be manufactured has been thoroughly considered in every detail, money is spent freely to enable each item of the machine to be produced in the most perfect manner with the least possible delay. Lastly, the workmen kept day after day on the same job attain a proficiency impossible under any other circumstances.

We see very much the same thing among our specialists in this country, such as the makers of engines, sewing machines, bicycles, small arms, and the like; but among the manufacturers of machine tools this system has not yet developed to nearly the same extent as in America.

In the use of the larger and heavier machines the specialist has no particular advantage over the general manufacturer beyond the fact that, in addition to fitting them with the special appliances before mentioned for economising time, he is able to run continuously on one class of work, and therefore does not lose by constantly changing from one job to another, but in lathes for repetition work, both for wrought and cast iron, he gains an enormous advantage; and it will not, perhaps, be out of place to describe here a few machines of this type which are largely used both in this country and in America for the economic manufacture of small parts.

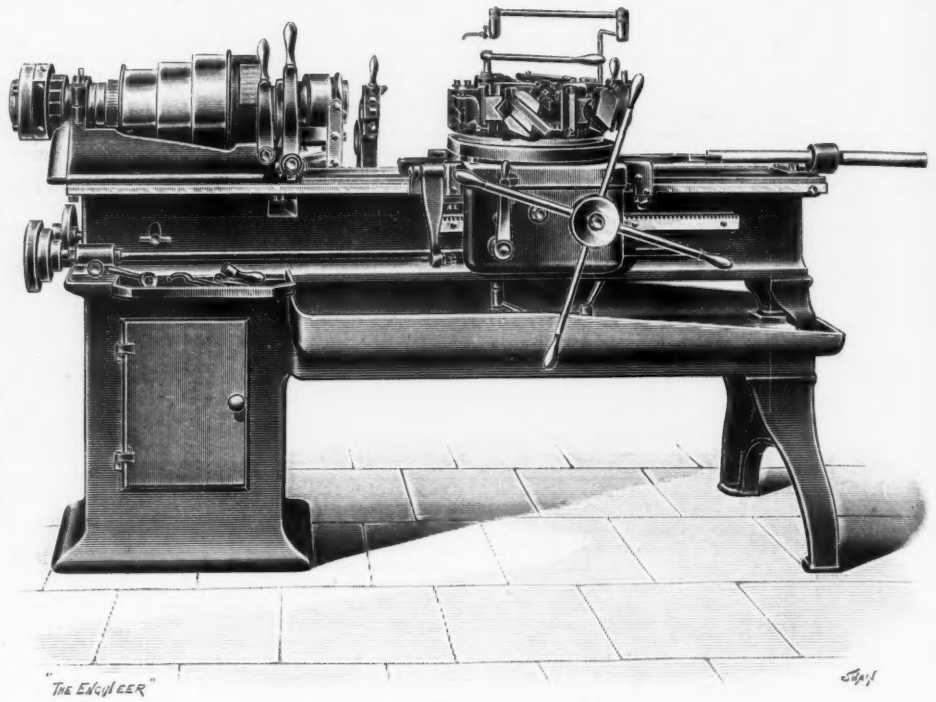


Fig. 1—AMERICAN TURRET LATHE

Fig. 1 represents a flat turret lathe manufactured by the Jones and Lamson Machine Company, of Springfield, Vermont. This machine is specially designed for the rapid production of steel and wrought iron articles not exceeding 2in. in diameter by 24in. long. It is made with a hollow mandril fitted with an automatic feed, the articles being turned and cut from the steel bar without forging, and is so arranged that it will deal equally well with bars of either round, square, hexagonal, octagonal, or flat section. A stop is provided for regulating the length of each piece to be cut off, thus obviating the necessity of measurement. The turret is provided with six tool holders, each working in conjunction with an automatic adjustable stop which arrests the travel of each tool at the required point. The tool holders are so arranged that any description of cutter can be employed either for turning, boring, cutting off, chasing, or tapping. The mandril can be rotated at nine different speeds to suit the various tools brought into action, three of which can be altered instantaneously without shifting the belt, and the motion of the mandril can be reversed instantaneously without stopping the machine. The lathe is also provided with a taper turning attachment and a holder for wide forming tools for turning handles and such like articles.

That our English manufacturers are alive to the advantages of this class of lathe is shown by the fact that Alfred Herbert, Limited—a firm who, by the way, follow American methods of manufacture perhaps more closely than any other machine tool makers in this country—are manufacturing an excellent and somewhat similar tool—Fig 2—for the same purposes. The lathe in question is made to deal with wrought iron and steel bars up to 2½in. in diameter by 24in. long—a somewhat larger rangethan that of the Jones and Lamson machine, and possesses the additional advantage that it can be employed on castings as well as wrought iron and steel work. In fact, the illustration shows it—the ordinary tools removed—arranged with special cutters for dealing with engine glands, the boring of the hole and the turning of the body of the gland being proceeded with simultaneously. This tool being somewhat less complicated than the Jones and Lamson lathe can be operated by boys to great advantage.

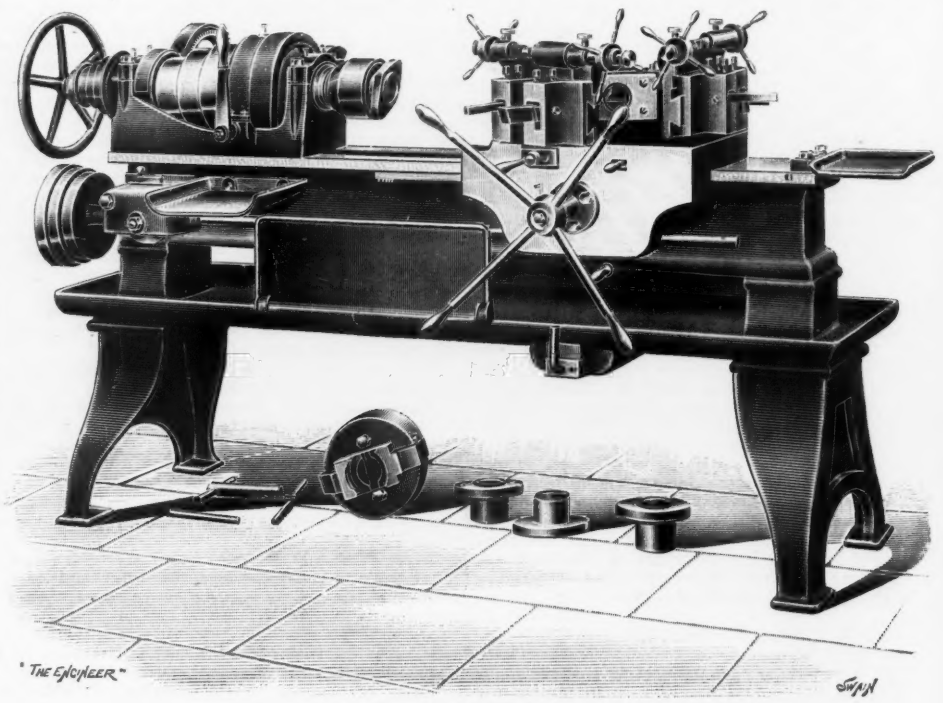


Fig. 2—ENGLISH TURRET LATHE

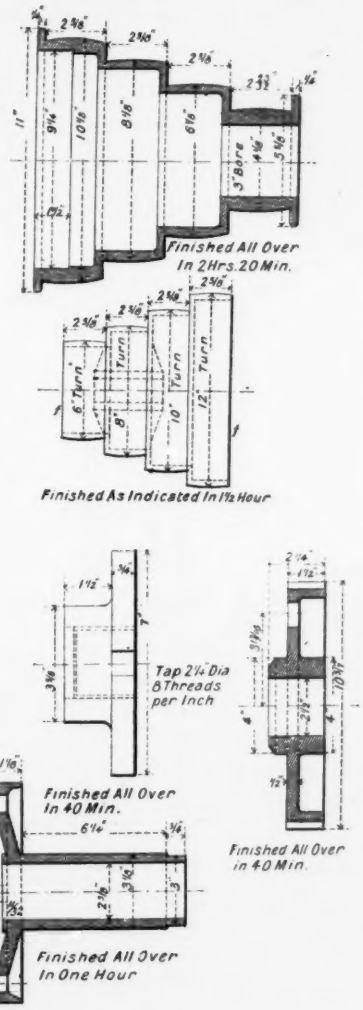
Neither of the lathes described above is unduly costly for the maintenance of tools, and as in every workshop, even where repetition is not assured, small wrought iron articles are required in large numbers, lathes of this type should be in great request, and it is a noticeable feature

of these machines that many of the small parts in use upon them are manufactured by tools of their own class.

The Gisholt lathe has been illustrated in THE ENGINEER for Feb. 3rd and March 24th. It is manufactured by the Gisholt Machine Company, of Maddison, Wisconsin. This lathe is made in five different sizes—the largest of which will swing up to 34in. over the ways, or 19½in. over the carriage, the traverse of the turret being 72in., and is of very substantial design for dealing with the heavy cuts to which it is subjected. The headstock spindle is actuated by powerful back gearing for heavy work, and, in addition to a hexagon turret head, containing six tool holders, which is mounted on the bed, the machine is fitted with a carriage supporting a second turret head, containing four tool holders, each of which is independently adjustable for height.

Power cross feed and taper turning attachments are also provided. Automatic feed and stops, independently adjustable, work in connection with each tool on the turret, and independent adjustable stops are furnished for each tool on the carriage turret head also. Four instantaneous changes of feed can be obtained, all of which are immediately reversible.

A reference to the illustration will show that this type of machine, at any rate, does not err on the score of weakness or lightness of design. Fig. 3 gives dimensioned sketches of a few castings produced by this tool, showing the amount of work done and the time occupied on each, results achieved by no other lathe at present in the



market. The one drawback to the use of this machine is that it is costly for maintenance of special tools, and a large amount of repetition is necessary before the outlay on these can be repaid.

A firm of general manufacturers with sufficient repetition to enable them to employ only one of any of the machines illustrated above will find a great advantage in doing so, but wherever a large quantity of one article has to be turned out and several of these tools can be kept at work, the saving effected by their use is still further increased. All machines of this type require a number of special tools to suit the various class of work they have to perform, and therefore the services of a good tool fitter even for a single machine are essential. When, however, three or four are in use, the changing of tools on each is not likely to be nearly so frequent as in the case of a machine working alone, and thus one tool fitter is sufficient to keep them going, and his expenses are divided among the lot. In addition to this it is claimed that a skilled turner is not required to operate these tools but, while this is admitted, there is no doubt that they do require the supervision of a first-class mechanic. If, therefore, one machine only is in use, an operator of fair mechanical ability is necessary, but with a number of these tools a mechanic can be employed to supervise the setting of the cutters and the adjusting of the machines, while the actual operating of them can be entrusted to less expensive hands working under his instructions. In this manner the specialist obtains a double advantage.

For the turning and screwing of stud &c., in large numbers, the automatic machines, five or six of which can be operated by a single man, of course effect an immense saving, but these are now so well known that any description of them would be superfluous, nor is it necessary to point out that the firm which has not sufficient repetition work to employ these tools must be content to manufacture such articles at a sacrifice.

The arrangement of the American workshops is not, as a rule, vastly superior to that of our own, and it cannot therefore be said that in this particular any saving in production is effected, but the value of time is more highly appreciated in America, and it is better economised in consequence. The system of providing a central tool room, a practice fast gaining favour in this country, is universal. The advantages of this are obvious, as a man operating a machine, when requiring to sharpen his tool, does not need to waste valuable time at the grindstone—which, by the way, is not suitable for this purpose—but is enabled at once to procure a fresh tool properly shaped and sharpened from the stores. Indeed, so much importance is attached in America to the value of the workman's time, that some shops are equipped with electrical bells, to enable him to summon a boy from the tool room to take his order for whatever he may require. When several highly-paid mechanics are employed, the value of the time saved by this arrangement is by no means trifling, and the result must be appreciable at the end of the year's trading.

To sum up, therefore, the question of cost of production, we find that the American machine tool maker has generally the advantage over his English rival on the following points:—(1) Economy of trade expenses; (2) the purchasing of material; (3) the production of castings; (4) the more extended use of special machinery and appliances; (5) the time saved by keeping his machines continually employed on one class of work; (6) a greater number of working hours per week; (7) the comparative freedom from trades unionism, and the assistance of more willing and enterprising workmen in consequence.

This is the explanation of the reasonable price of American machinery. The low price of their tools is more marked among the smaller machines, as these can be naturally manufactured in greater quantities than the heavier class of tools; but whether light or heavy machines are required, the American makers can deliver either into this country at prices sufficiently near those of the English makers to reduce this question to a matter of small importance when the purchaser is making his selection.

LITERATURE.

The Kinetic Theory of Gases: Elementary Treatise, with Mathematical Appendices. By Dr. OSKAR EMIL MEYER, Professor of Physics at the University of Breslau. Translated from the second revised edition by ROBERT E. BAYNES, M.A. London: Longmans, Green, and Co. 1899.

IT is probable that many of our readers are familiar with the first edition of Dr. Meyer's book. But there must be numbers who are not, and to whom we venture to recommend the work, for reasons we shall state in a moment. The treatment of the theory of gases has hitherto been very largely mathematical, and very abstrusely mathematical at that. The result has been that a not unimportant body of engineers who do not love mathematics for their own sake, and, indeed, regard them as tools rather than sources of recreative delight, has been repelled from the study of a subject full of interest. There are, too, many physicists to whom the higher mathematics are a sealed book. These men have, on the one hand, been attracted to an inquiry into the mechanics of the gases, and, on the other, driven away by the belief that they could do nothing with the subject. The volume before us is a direct proof that the mathematics of the kinetic theory of gases may be kept quite distinct from its physics. That, in fact, the theories involved can be rendered quite intelligible without recourse to algebra. "I undertook," says our author in his preface, "to exhibit the kinetic theory of gases in such a way as to be more easily intelligible to wider circles, and especially to chemists and other natural philosophers to whom mathematics are not congenial. To this end I endeavoured, much more than was otherwise usual, not only to develop the theory by calculation, but rather to support it by observation and experiment." The result of this method of treatment is in all respects satisfactory.

The student approaching the theory of gases comes to it, as a rule, full of a preconceived idea of what a gas is. To most men a gas is a homogeneous fluid in enclosed vessels at rest—which exerts a continuous pressure on the walls of the enclosing vessel in much the same way that a steel spring presses, or water acts when under a head. No conception can be more fundamentally erroneous. In order to form a correct idea, or mind picture, let us imagine a large room, inside which there are a great number of ivory balls, each, say, the size of a bicycle ball. These are very far from filling the whole room. In fact, quite considerable empty spaces exist. Next it is necessary to picture to ourselves all these balls in violent motion, darting in every direction at enormous velocities. Being almost perfectly elastic, they recoil when they strike an obstacle such as the wall of the room; but they also come into collision with each other, and then behave precisely as billiard balls do, flying off from each other at particular and well-defined angles. The balls all move in straight lines unless they are constrained to rotary motions by centrifugal and centripetal forces, or being heavy, they may, under the influence of gravity, describe curved paths. The continual pounding of these balls against the walls of the room produces the effect of pressure, and in effect is quite different from the pressure of water in a vessel, in that the last is static, while that of a gas is purely kinetic—the result of motion.

Now it is easy to see that in what takes place among the million or so of balls in our room, the mathematician can find wide scope for disquisition. But we must go yet further, and imagine that under certain conditions the balls may come so close together that they will adhere by a species of attraction, and we may also suppose that each ball has been dipped in some sticky material, such as honey. The first of these conditions is represented by liquefaction, under pressure and cold. The second is the best illustration of the viscosity of gases which suggests itself to our minds. It is not, we think, remarkable that the mathematician with such physical conditions before him, should find in gas a happy hunting-ground. In fact, the subject is one that lends itself almost without limit to mathematical treatment.

The great beauty of the book under review is that in it Dr. Meyer has succeeded in stating nearly all the theory that is accepted in a quite intelligible way, almost entirely without the aid of mathematics, for which the reader is referred to the appendix. The work is, of course, far too large and the subject too vast to admit of its being dealt with adequately in the shape of such a brief notice as this must of necessity be.

Almost from the first, our author, having stated a law, goes on to explain how it has been deduced, and what are the more prominent of its results. Thus, for example, he shows how the mean speeds at which gas molecules—to which the elastic balls we have cited above answer—have been obtained. The molecules of air move with a velocity of 485 metres, or 1591ft. per second, or, say, 1085 miles an hour. This is higher than the muzzle velocity of the round shot fired at Trafalgar. The motion is due to heat; but how or why must remain, at this time at all events, a mystery. No one knows why motion can produce heat, or heat motion. It is true that heat is itself a mode of motion; but it is so different in character from the species of movement of which our senses can take direct cognisance, that we are quite justified in stating that the method of the transformation of one mode into the other is unknown.

There are some weak places in Dr. Meyer's enunciation, which are not so much his fault as that of the theory. For example, the explanation given on pages 25 and 26, of the reason why the atmosphere cannot escape from the earth, can hardly be regarded as wholly satisfactory. Again, on page 342 we find this passage, "When two absolutely hard bodies collide, the hardness of which, together with the impossibility of compressing them, causes a repulsive force to come suddenly into play, at the moment of the collision," the reader is left quite in the dark as to how any repulsive force can be brought about under the conditions. This passage, we may add, is to be found in the chapter on the "Direct Properties of Molecules," which is in certain respects imperfect. It is unsatisfactory in that it contains propositions which, however true in a mathematical sense, fail to convey any intelligible conception of facts to the reader. Thus, again for instance, we have the important proposition, that "the laws of elastic impact are valid for the encounter of molecules, without thereby ascribing elasticity to the molecules themselves." It is, of course, well known that there are certain difficulties in the way of reconciling various theories explaining different phenomena; but this is not the fault of Dr. Meyer.

Step by step, almost page by page, our author leads the reader on from the consideration of one phenomenon to another, always explaining in very well-chosen terms what the true nature of the phenomenon is, who has investigated it, why it occurs, and what are its consequences. Examples of this, of course, may be found on almost every page. We may cite one taken almost at haphazard, viz., Chapter IV., setting forth the points of difference between ideal and actual gases. It is very difficult to say what point our author has left untouched, what question unconsidered; and the volume, because of its numerous references to various investigations, gives an adequate idea of the enormous amount of research which has been expended on the subject with which it deals.

It may, perhaps, be as well to warn our readers that they will find no practical information on such subjects as refrigeration, air compression, transmission of power by air, and so on. What is generally known as Joule's Effect is not so much as mentioned directly by Dr. Meyer, who, indeed, speaks with a somewhat hesitating voice concerning the loss of temperature which takes place when gas flows from one vessel into another. This phenomenon has no explanation on the theory of a perfect gas. "It proves, therefore, that a secondary circumstance has not been sufficiently taken into account, and scarcely leaves room for doubt that the cause which has been neglected is the cohesion of the gases, to overcome which during their expansion into vacuum a part of the heat energy must be taken up."

We believe we have said enough to indicate the nature of the book, and it must suffice to add that the work of the translator has been well done. Mr. Baynes writes very good English, and appears to have got accurately the author's meaning, without descending to write a literal translation. We need scarcely add that the publishers have done their part thoroughly well.

BOOKS RECEIVED.

Journal of the Royal United Service Institution. Vol. xliii., 15th November, 1899. No. 261. London: J. J. Keliher and Co. Price 2s.

Encyclopedie des Aide-Memoire: Analyse Microchimique et Spectroscopique. Par M. E. Pozzi-Escot. Essai des Matières Textiles, par J. Persoz. Gauthier-Villas: Quai des Grands-Augustins, 55, Paris.

An Introduction to the Study of Central Station Electricity Supply. By Albert Gay, M. Inst. E.E., and C. H. Yeaman, A. Inst. E.E. With over 200 illustrations. London: Whittaker and Co. 1899. Price 10s. 6d.

C. H. Bailey's Tables of Distances from Port to Port. Revised edition. 1899. Containing over 36,000 distances, being more than in any other book yet published. Newport, Mon.: C. H. Bailey, Tyne Engine Works. Price 7s.

UTILISATION OF HIGH-FURNACE GASES FOR POWER IN GAS ENGINES.

By BRYAN DONKIN, M. Inst. C.E.

No. III.

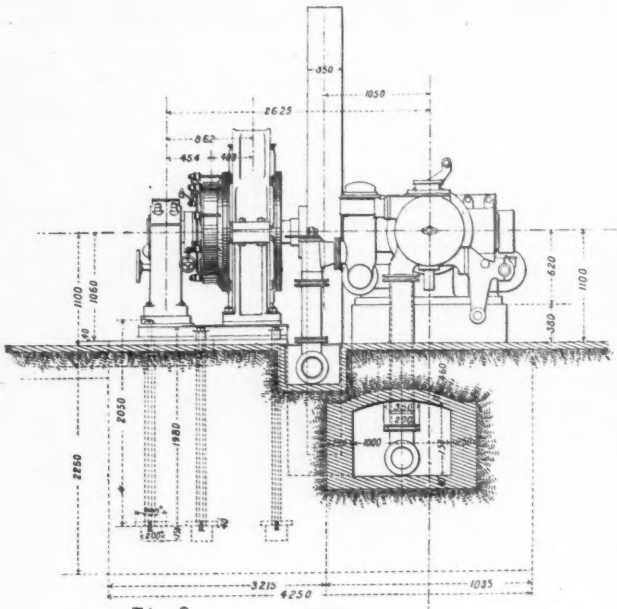
THE Deutsche Kraft Gesellschaft, already mentioned as the makers of the 600-horse power Oechelhaueser engine at Hörde also supplieda 60-horse power Otto 4-cycle motor to the Differdingen Ironworks in Luxemburg. Upon this engine the most important tests yet made on any motor driven with high-furnace gases were carried out by Professor Meyer in October, 1898. Fig. 6 gives a series of fifteen indicator diagrams taken on the same paper during the trials. Full particulars will be found in *Zeitschrift des Vereines deutscher Ingénieure*, vol. 43, No. 16, p. 453. The cylinder diameter of the engine was 17in.; stroke, 27½in.; speed, 160 revolutions per minute. The engine indicated 79·5-horse power, with a consumption of 79·4 cubic feet = 2·25 cubic meters of high-furnace gases per indicated horse-power hour. The brake horse-power was 65·3, with a consumption of 96·7 cubic feet per brake horse-power hour. The heating value of the gas taken in a calorimeter was 105 B.T.U. per cubic feet, and the heat turned into indicated work 30·2 per cent. The trial was made with the care and accuracy which distinguish all Professor Meyer's work. The results are good, but rather more favourable than those obtained in ordinary practice with high-furnace gases at present.

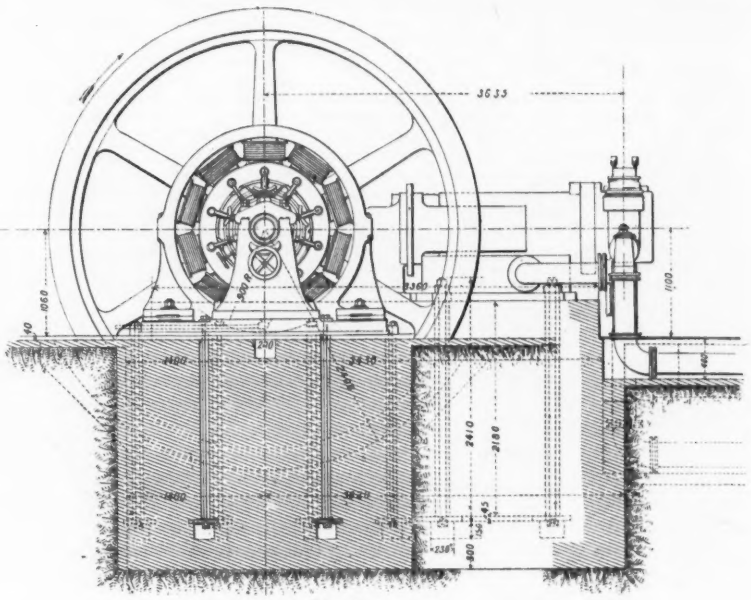
MM. Körting, one of the most important engineering firms in North Germany, have up to the present confined themselves to smaller powers, and therefore have not made as many gas engines for this class of work as others. Figs. 7, 8, and 9 give a plan, elevation, and end view of the single-cylinder 4-cycle 100-horse power engine built by them for the Donnersmarck Ironworks in Silesia. It is used to drive a dynamo, as shown, and its capacity is 760 ampères and 110 volts. This firm are making two other engines of the same size, and two of 125-horse power, all for work with high-furnace gases and driving dynamos direct. Till lately it has been considered almost impossible to obtain electric light from gas engines coupled direct to the dynamos, but the difficulties in the way have now been overcome.

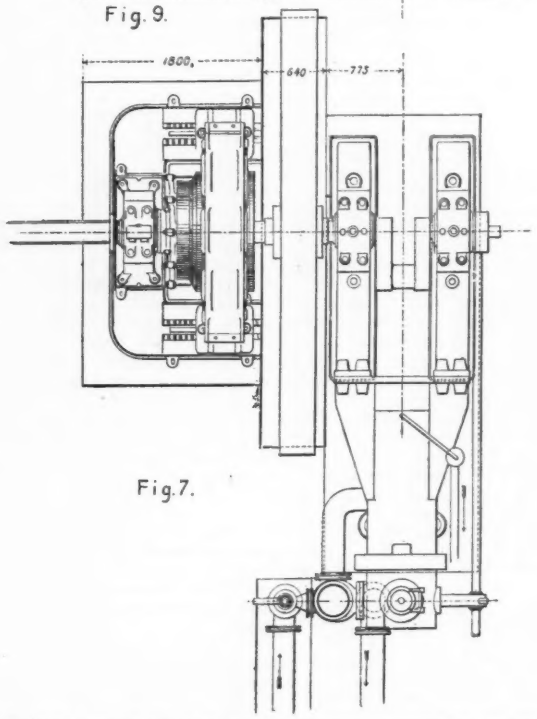
No large engines appear at present to be working in France with high-furnace gases, but several have been ordered, especially in Eastern France. The Creusot firm are, we understand, making a 3000-horse power plant for De Wendel et Cie., and a plant of several engines on a very large scale, developing some 5000-horse power, and delivering iron fit for castings, instead of pig iron as usual, is to be erected at Poissy.

Coming now to consider the work done with high-furnace gases in England, it must be admitted that it has hitherto been chiefly experimental. Large power engines are now proposed, but as far as the writer is aware, none are as yet at work. The first engine driven with these gases was a 30-horse power 4-cycle Acmé, started at the Glasgow Ironworks, Wishaw, in 1895. The initiative in the system was taken by Mr. Thwaite, who has patented a process for drawing off the gases from blast furnaces and purifying them by electricity. Foreign experts seem in most cases to have simple methods of their own for treating the gases. Possibly they have a freer hand in this matter, which may partly account for the much greater development of the industry in Germany and Belgium than here.

The engine at Wishaw has been used to drive a dynamo, and runs satisfactorily, but it is only a small power experimental plant, and can scarcely utilise high-furnace gases to the best advantage. It has a cylinder diameter of 12in., with 20in. stroke, and the consumption of high-furnace gases of 98 B.T.U. heating value per cubic foot is 95 cubic feet per brake horse-power hour. The furnace is fed with Scotch splint coal—instead of coke, as usual—and the gases are therefore rather richer than those generally produced elsewhere. The engine was tested by Mr. Booth while driving a dynamo, and was found to give about one electrical horse-power per hour per 1½ lb. of this coal fed into the furnace, and to consume about 140 cubic feet of gas per electrical horse-power. A small 25-horse power experimental engine was







100-H.P. GAS ENGINE AT THE DONNERSMARCK IRONWORKS, SILESIA—ELEVATION AND PLAN

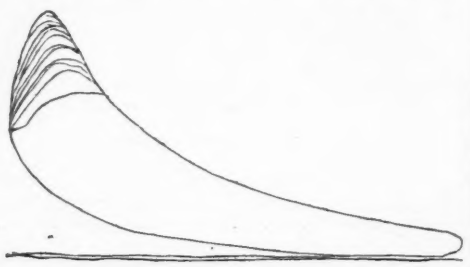
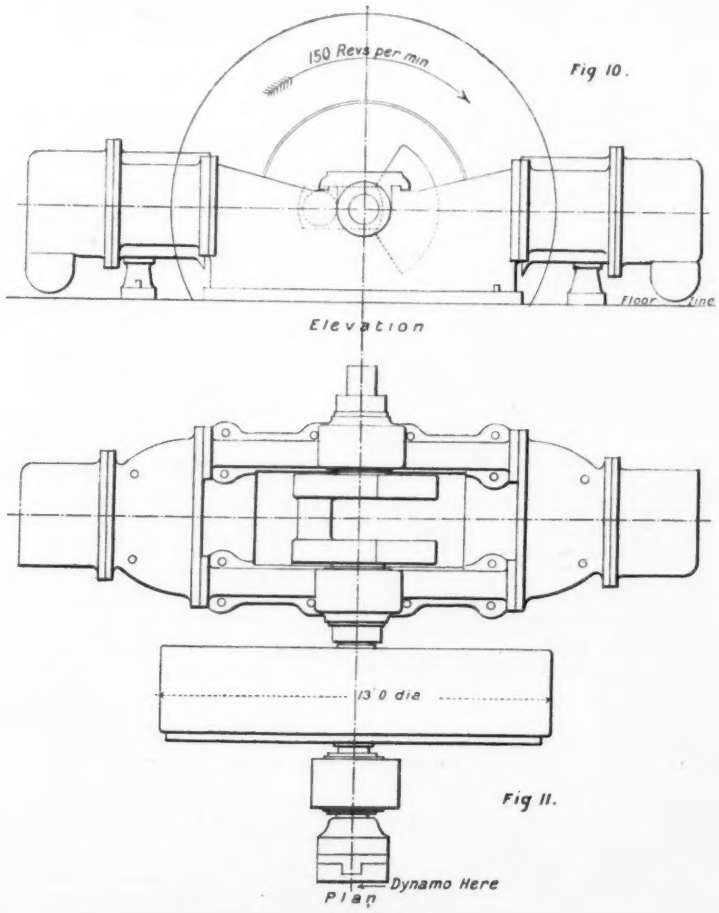


Fig. 6—DEUTZ OTTO GAS ENGINE—INDICATOR DIAGRAM

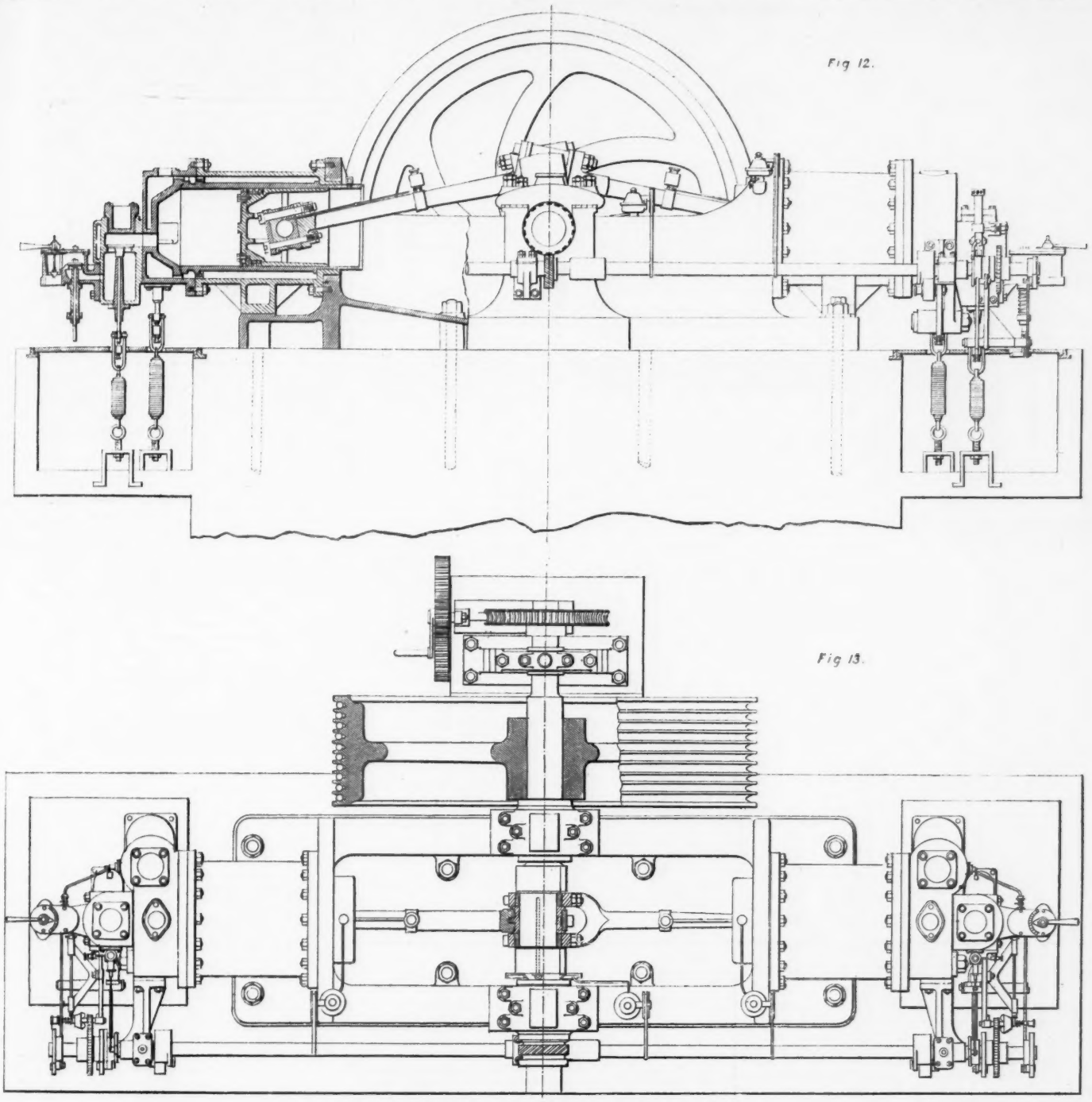


530-I.H.P. GAS ENGINE, MADE BY CROSSLEY BROS.

put up at the Frodingham Ironworks, near Doncaster, about two years ago. This engine was also an Acmé and gave good results, although the gas was very poor.

A larger 160-horse power plant has been working at Barrow-in-Furness; and a much larger installation of 1000-horse power in all, or 250-horse power per cylinder, is now in course of construction. A 150-horse power plant has been supplied by the Blast-Furnace Power Syndicate to the Phœnix Hütte Works, in Germany, for driving electric machinery.

Figs. 10 and 11 give an elevation and plan of a 530-horse power two-cylinder motor, built by Messrs. Crossley for producer-gas, which can be modified without difficulty to work with high-furnace gases. Fig. 11A is a general view of this engine. It has, as will be seen, two cylinders opposite each other working on one crank. The well-known firm of Andrew and Co., of Stockport, have not yet made engines to drive with these gases. Figs. 12 and 13 show the general design of a 500-horse power plant, consisting of two 250-horse power engines, double-cylinder, which are intended for work with coke-oven gas. Only one engine developing 250-horse power is seen in the drawing. These engines are fitted with two ignition tubes, one as a reserve. On the Continent, with these large power motors, the charge is always fired electrically. Figs. 14 and 15 are drawings of a 250-horse power single-cylinder engine now in course of construction by the Premier Gas Engine Company for use with high-furnace gases. This is the first large power engine, if we except the contemplated work at Barrow, built for these gases in England. We trust it may speedily be followed by many more, and that the new industrial development, of which an imperfect sketch has here been given, may soon be vigorously taken up by English enterprise and engineering skill. We have no doubt that once the suitability of the gas engine for use with blast furnace gases has been established, we shall hear of some of the most important plants for this purpose being made in this country.



250-B.H.P. STOCKPORT GAS ENGINE—ELEVATION AND PLAN

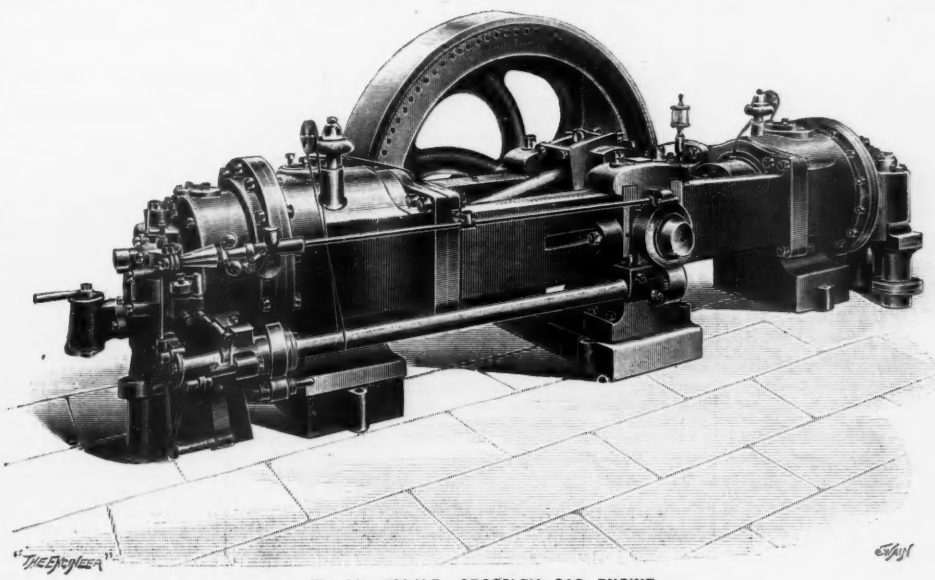
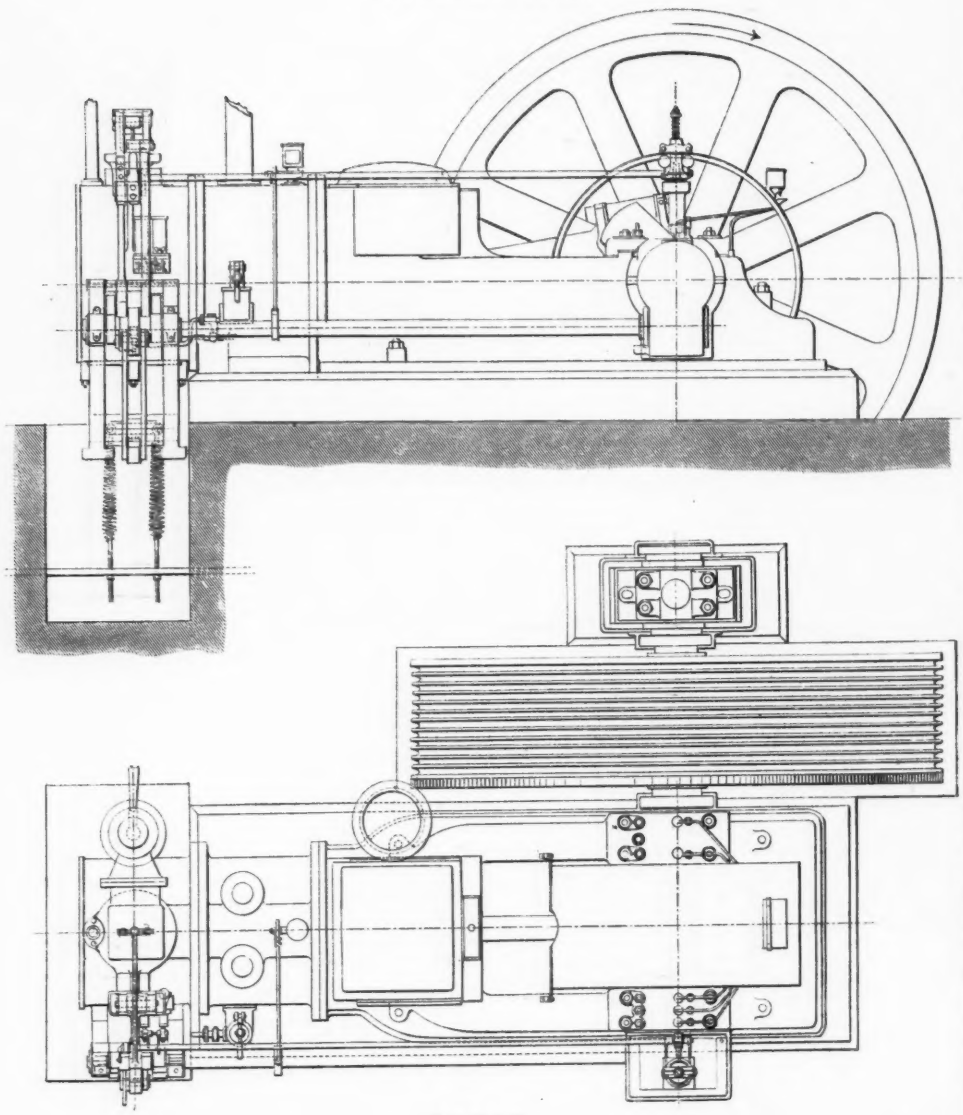


Fig. 11a—530-H.P. CROSSLEY GAS ENGINE

ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution, before Easter:—Mr. C. Vernon Boys, six Christmas lectures—specially adapted for young people—on "Fluids in Motion and at Rest;" Prof. E. Ray Lankester, twelve lectures on "The Structure and Classification of Fishes;" Dr. W. H. R. Rivers, three lectures on "The Senses of Primitive Man;" Professor H. H. Turner, three lectures on "Modern Astronomy;" Dr. Charles Waldstein, three lectures on "Recent Excavations at Argive Heræum, in Greece;" three lectures by Sir Hubert H. Parry;" Mr. W. L. Courtney, three lectures on "The Idea of Tragedy in Ancient and Modern Drama;" The Right. Hon. Lord Rayleigh, six lectures on "Polarised Light." The Friday evening meetings will begin on January 19th, when a discourse will be given by the Right Hon. Lord Rayleigh, on "Flight;" succeeding discourses will probably be given by the Hon. C. A. Parsons, Professor J. Reynalds Green, Mr. H. Warrington Smyth, Professor J. H. Poynting, Major Ronald Ross, Professor Frank Clowes, Sir Benjamin Stone, M.P., Professor J. Arthur Thomson, Sir A. Noble, Professor Dewar, and other gentlemen.

250-H.P. PREMIER GAS ENGINE

(*For description see page 589*)



Figs 14 & 15

ELECTRIC LIGHTING AND REFUSE DESTRUCTION.

A DECISIVE step in connection with the proposed electric lighting installation for the parish of Bermondsey has at last been made. It is unnecessary to enter into the past history of the scheme beyond mentioning that it has undergone the ordeal of two parliamentary sessions, and that a combined electric lighting and refuse destructor installation on a moderate scale was approved by the Vestry of Bermondsey over a year age. Quite recently, however, Messrs. Kincaid, Waller, and Manville, consulting engineers to the Vestry, received instructions to prepare a sketch plan and elevation showing the type of buildings proposed to be erected. In submitting these for the consideration of the local authority, they point out that the design has been arranged on a somewhat liberal scale, so as to allow not only for the erection in the engine-house of the plant now proposed, but also for extensions to double the output of that plant. As regards the destructor and boiler-house, the accommodation would only be sufficient to enable the first set of boilers and cells to be erected, thus necessitating an extension of this part of the buildings on additional plant being laid down in the engine-house. The idea of the Vestry's Electric Lighting Committee has evidently developed during the past year or two, since it is proposed to extend the mains materially beyond the limits originally projected. In these circumstances, and having in view the rapid extensions in the case of other installations owned by London local authorities, the engineers consider that the size of the units of plant should be increased so as ultimately to avoid having a small plant of a comparatively uneconomical size in the generating station. They have accordingly prepared a revised estimate, which contemplates the doubling of the output of the plant to be installed at the initial stage.

A glance at the detailed estimates shows that under the extended scheme an expenditure of £47,960 is now proposed on buildings, a six-cell destructor, machinery, boiler-house plant, mains, and public lighting to the extent of twenty arc lamps. It is calculated that the generating plant would allow of 10,500 eight-candle power lamps being connected to the mains; and the revenue from these, with current supplied at 6d. per unit, and from the public lamps, is estimated to amount to £5527, which sum is increased to £6313 by adding £786 as the net saving on the refuse destructor, as in the original estimate. The annual maintenance is put at £3300, which, deducted from the revenue of £6313, leaves a balance of £3013. The interest and sinking fund are stated by the engineers to be at the rate of 2¾ per cent. for a term of forty-two years, and to be equivalent to £1980 on a total loan of £48,000. If this amount is deducted from the gross profit or balance of £3013, the net surplus reaches the sum of £1033. As the report bears the date of the 15th ult., it is surprising to find the interest placed at the low rate of 2¾ per cent. It is impossible to obtain loans at present for electric lighting purposes at less than 3¼ per cent., and there is every probability of money being dear for a period of at least twelve months; whilst at the same time the £4000 proposed to be expended on the destructor would have to be repaid in a much shorter period than forty-two years.

The consulting engineers state that in making the estimates referred to, the prices taken are those at which similar contracts have been let during the past few months, and in that connection attention is drawn to the fact that the cost of building work has increased during the last year from 25 per cent. to 50 per cent. according to the class, and that of machinery by upwards of 50 per cent., owing to the rise in the price of raw materials. The questions of revenue and maintenance are said to have been taken on the most conservative bases, and with the size of plant proposed, the engineers believe that the revenue will exceed that indicated in the estimate, whilst the maintenance should be less, leaving a larger surplus after provision for interest and sinking fund than that shown in the estimate. The Vestry, after some discussion, have adopted the report, and have authorised the engineers to prepare a specification for the erection of the electric lighting station, and at the same time decided to issue advertisements for the supply and erection of the refuse destructor.

LIGHT RAILWAYS IN MIDDLESEX.

IT is a noteworthy fact that, apart from the various schemes for the construction of new tramways and the extension of existing lines in the metropolis, coupled with several proposals for what the London County Council is disposed to term "light railways," in order, as it would appear, to supersede the vestries and district boards as the road authorities, the neighbouring counties of Surrey and Middlesex have under consideration light railway projects which may be expected to involve an expenditure of considerable sums of money. The totals of the London schemes, which will shortly be submitted, partly to Parliament and partly for the consideration of the Light Railway Commissioners, are expected to necessitate an outlay of at least £1,000,000. Thirty-three miles projected by the Surrey County Council are still in an undecided position, whilst the schemes formally approved by the Middlesex County Council, and proposing also a heavy expenditure, yet require the final confirmation of that body. In one important respect the Middlesex light railway proposals differ from those of London, namely, that in the Middlesex Light Railways Order No. 1 the Council is joint promoter with a company; whereas, in the case of London, it has been decided to omit the clause, which is said to have been inserted in every Order hitherto granted by the Light Railway Commissioners, giving power to lease the lines sanctioned, if considered desirable by the promoters of the Order.

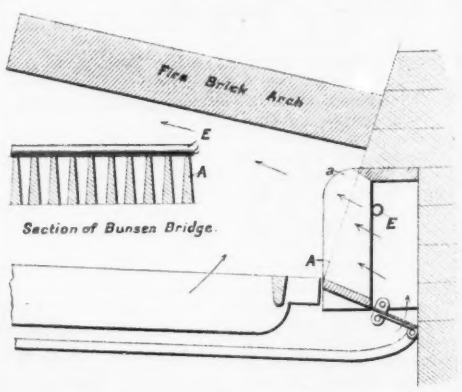
The Middlesex Light Railway Order No. 1 proposes the construction of eleven lines in Tottenham and Wood Green, Finchley, Hornsey, Hendon, Wembley, Edgware, Little Stanmore, Great Stanmore, and other adjoining districts. It is being promoted jointly by the County Council and the Metropolitan Tramways and Omnibus Company, and negotiations are proceeding between the two parties with a view to arriving at an agreement with regard to the construction and operation of the light railways. It is possible that the lines will be built by the County Council, and leased to the company, in which case any share of the profits accruing to the Council would be devoted to the purpose of relieving the county rates. The exact details of the arrangements will, however only be ascertained at the next meeting of the Council. In addition to the eleven lines comprised in the first Order, the County Council has resolved to apply for a second Order to authorise ten other lines in Friern Barnet, Harlesden, Wembley, Harrow-on-the-Hill, and Wealdstone, and in Isleworth, Twickenham, Teddington, Hampton, and Hampton Wick. The lines in the latter five districts were promoted some time ago by the London United Tramways Company, but the application for an Order was refused by the Light Railway Commissioners. The object of the County Council is gradually to construct lines so as to connect the different districts together, and to bring the termini of the railways to the boundary of London, in order to join the metropolitan tramway system. In this connection the Council is prepared to negotiate for an interchange of traffic between Middlesex and London or Surrey, but it intends to resist any attempts, such as those recently made by the London County Council, to interfere with the independence of Middlesex in its own county.

It should be mentioned that Mr. Wakelam, the county engineer and surveyor of Middlesex, has prepared plans of the proposed light railways for deposit with the Commissioners, who are not expected to consider the applications for powers until the spring of next year. As it is intended that at least some of the lines shall be worked by electric traction, the services of Mr. C. E. Gadsby, Wh. Sc., M.I.E.E., were recently obtained to report on the subject. His report, although in the hands of the Parliamentary Committee, has not yet been placed before the County Council; but it is anticipated that it will be considered in the course of the next few days, when the light railway question will be fully discussed by the Council. One point which will then be settled relates to the paving of the roads outside the rails. Under the Tramways Act companies are bound to maintain and keep in good condition and repair so much of the road upon which the tramways are laid as lies between the rails, and so much of the road as extends 18in. beyond the rails on each side. The County Council is to be asked to express the opinion that the 18in. should be extended to 3ft., but no reasons have yet been adduced in explanation of the proposed change, which the Light Railway Commissioners may probably consider to be unnecessary.

A NEW SMOKE-PREVENTING FURNACE.

SOME very successful experiments have recently been made in Liverpool with a smoke-preventing furnace, the invention of Mr. D. Elliot Alves, whose address is for the time being Hotel Cecil, London.

The construction of the furnace will be readily understood from the accompanying engraving, reproduced from Mr. Alves' patent specification, which shows it fitted to a water-tube boiler. The bridge A consists of fire-clay or cast iron slabs, with vertical slots in them; behind there is a steam pipe E, with perforations. The steam jets blowing through these induce a strong current of air through the bridge, which is directed horizontally towards the fire-door and under the brick arch. It is claimed that the effect is that of a Bunsen burner. Perforated furnace bridges are as old as the steam engine. When they have been successful in preventing smoke they have directed such an intense flame



ALVES' BUNSEN FURNACE

against the crown plate that it was burned. Mr. Alves gets over this difficulty by directing the steam, as we have said, horizontally towards the fire-door.

It will be seen that the Alves bridge is virtually a section of the grate placed vertically, and the fireman must be trained to keep coal away from the bridge. We understand that no trouble has been experienced on this score. The experiments at Liverpool showed that with heavy fires of bituminous coal clouds of black smoke rolled from the top of the chimney when the steam was shut off from the pipe E. In less than half a minute after the jets were turned on the smoke entirely disappeared.

We are very chary of saying much in favour of any smoke consumers, we have seen so many failures. But we have no hesitation in saying that Mr. Alves' apparatus seems to be quite satisfactory. It is constructed on correct principles, and ought to work very well. It is inexpensive, and there is nothing about it to wear out rapidly.

INSTITUTION OF MECHANICAL ENGINEERS.

ON Friday evening, December 8th, Professor Ripper read a paper at the Institution of Mechanical Engineers on "A Continuous Mean-Pressure Indicator for Steam Engines." It will be found printed on another page. Several members took part in the discussion. The first speaker was Mr. Henry Lea. He drew attention to the laborious manner in which the average horse-power of an engine with varying load had to be worked out from a number of superimposed diagrams. About twenty years ago he had made an attempt to obviate all this, and had devised a modification of Richards' indicator. It consisted of a simple piece of apparatus which could be attached to the indicator in about two minutes, so that if it was desired to check the valve-setting, ordinary cards could be taken first and then this instrument could be applied. He showed the principal part of the mechanism. It consisted af a tubular arm which replaced the working arm of the Richards indicator. Through this there passed a spindle with a bevel wheel at the hinged end, and a conical roller at the other—see Fig. 1. The taper of this roller was arrived at by drawing lines from the centre of oscillation of the arm. The roller had a number of fine longi-

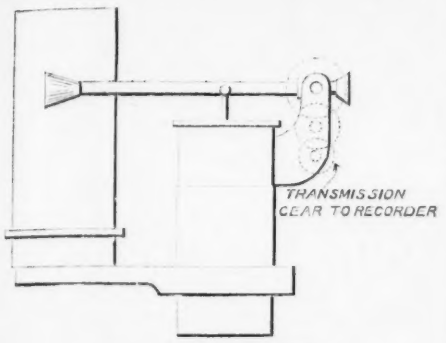


Fig. 1—LEA'S INDICATOR

tudinal grooves cut on it. Thin paper, well oiled, was wrapped round the drum. As the arm moved up and down the roller revolved more or less, an action similar to that on a planimeter taking place. This motion was transferred by means of a train of gearing to a recorder, which gave the total area of all cards taken within a certain period, usually an hour. Mr. Lea then showed how the horse-power could be calculated and how the calculation could be shortened by the use of a constant. He had tried the instrument on slow-running engines with gratifying results, but when used for high speeds the momentum of the roller caused it to give wrong indications.

Mr. Stephen H. Terry then described an average power indicator which he had designed in 1877. Unfortunately it had never been made, but he believed it would work well, though its cost would be against it. Mr. Terry has kindly lent us his original drawings, from which Figs. 2 and 3 are reproduced, and from these the construction and working of the indicator will be readily understood. Fig. 2 shows the indicator dials separately; they are reproduced in order to show how the scales are arranged. The drums for paper on the top of the apparatus seen in the general plan are not necessary to the instrument, but can be employed to keep a record over any desired period of time.

This instrument is designed to show (1) on the left-hand dial, the mean effective pressure per square inch of piston area, as well as the mean effective pressure per circular root of piston area. (2) It shows on the right-hand dial the speed in feet per minute at which the piston is at any moment moving. (3) It shows—on the central dial—the indicated horse-power per circular foot of piston area, and by graduating specially the three inner scales—see general drawing—to suit the diameter of cylinder and length of stroke of engine under

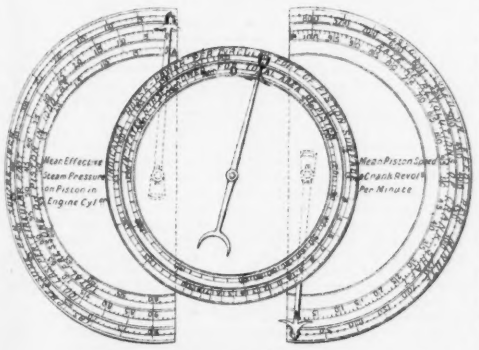


Fig. 2—TERRY'S INDICATOR DIALS

consideration, the instrument will also indicate (1) the total effective pressure on the whole area of piston, (2) the revolutions of engine crank shaft, (3) the total horse-power at any moment of the engine under consideration.

In the case of double-cylinder engines the instrument is placed between the two cylinders, and branch steam pipes are fitted to both ends of the two cylinders, with suitable stop cocks, so that first the power given off by one cylinder can be read off, and then that of the other. In the case of compound engines, whose cylinders are of different diameters, extra scales are graduated on dials A and D, or these scales are omitted and the power developed by the cylinders is found by multiplying the power per circular foot of piston by the number of times the area exceeds a circular foot. The apparatus consists of two separate parts. (1) The measuring apparatus, which is confined to the lower part of the case, may be again sub-divided into two parts, namely, the one for measuring the mean pressure on every square inch of piston surface, the other for measuring the mean speed of that piston. (2) The indicating apparatus which renders these measurements visible to the eye, which consists of three similar pinions, 2in. pitch circle, thirty-two teeth, two double racks, two fixed dials, and a movable dial. Above these are shown in the longitudinal vertical section three paper drums for recording the speed and pressure during every hour of the day.

The pressure-measuring part of the apparatus consists of a vertical brass cylinder, 1⅜in. diameter, *i.e.*, 2in. area and 3in. stroke; in this cylinder moves a piston, attached to a long rod. The piston is steam-tight, but nearly free from friction. The steam from the engine is led to and from this cylinder from the opposite ends of engine cylinder by means of the two ½in. steam pipes shown, and is distributed by the simple form of piston slide valve, "puff-and-dart valve," shown, which is driven to and from a length of $\frac{7}{16}$in., solely by the difference in pressure on its two sides. Its ports are so arranged that the "steam" side of the engine piston is always open to the under side of the instrument's piston, while the "exhaust" side of the engine's piston is open to the upper side of the instrument's piston.

If preferred, another arrangement can be used, consisting of a four-way cock, with the passages so cored out that there is no lap at the joint on the face, and thus so soon as the cock has closed one passage it opens the other, and as it is on its centres at the same moment that the engine is passing centres, the momentary closing is of no importance. It could either be revolved by means of a shaft and bevel wheels from the engine, or it might be reciprocated from the slide-valve rod, or by separate eccentric cam, or pitch chain. The long piston-rod of the instrument passes up through a stuffing box and carries a disc, against whose upper surface a spiral spring presses in such a way that when the piston-rod and disc are quite down the spring is just free from contact with the disc. The piston-rod then passes up through an oil cylinder with a regulating cock, which arrangement prevents the rapid motion of the piston during every stroke of the engine from the variation in pressure, and causes the piston to take up a mean position, to the mean upward pressure of the steam minus the downward pressure of the spring and the counterpressure of the exhaust steam; this position can be the mean of a few strokes or of many, according to the position of the regulating cock.

The piston-rod ends in a stirrup coupling in such a way that the rod can turn partially under the action of the spring without turning the toothed rack or causing unnecessary friction in the guides. The apparatus for measuring the piston speed consists of three brass tubes, the central one 1⅜in. internal diameter, the side ones are each $1\frac{5}{32}$in. internal diameter; the area of the first is therefore 2in., while that of the others is 1in. These three vertical tubes are connected together by horizontal telescopic tubes at their upper and lower ends, which allow the mercury and the air to pass freely from one to the other. The two horizontal screws shown are for adjusting the lateral distance of the tubes from the central one. A brass float, carrying a long rod, rests on the mercury in the central tube, and is free to rise and fall with the level of the mercury therein. The whole apparatus is put in revolution by means of the long

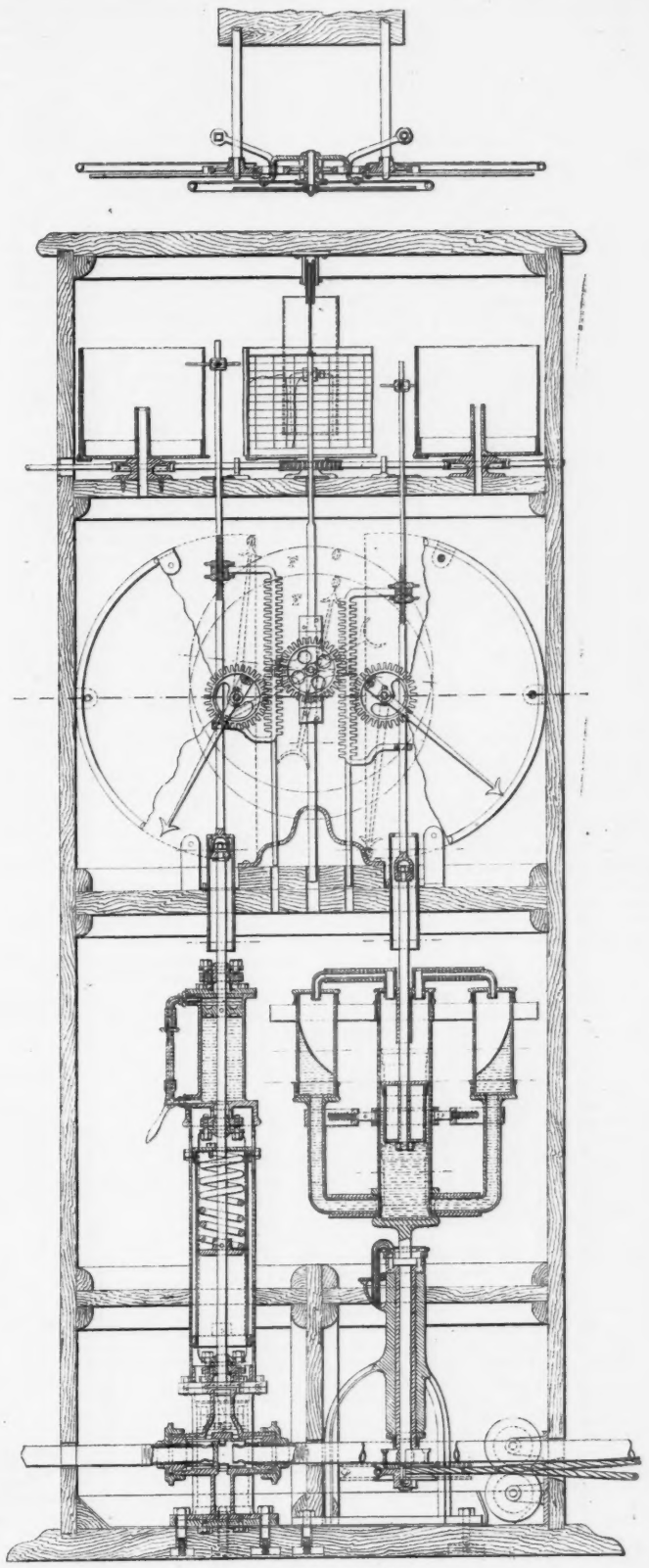


Fig. 3—TERRY'S INDICATOR

spindle shown, at whose lower end is a pulley of such a size that the spindle shall make, say, two revolutions to every foot of piston speed per minute. The rod before mentioned ends in a similar way to the piston-rod, in that it is coupled to a stirrup coupling. Both these couplings form part of long brass or steel rods square in their lower parts beneath the screwed parts, by means of the two nuts shown; a frame carrying a double-toothed rack can be adjusted at any height on both these rods; the racks are guided vertically by the two tails shown. Into the outer teeth of these racks gear two similar pinions, which carry pointers, which show respectively the mean pressure and the piston speed on their two dials.

Into the middle teeth of the two racks gear the opposite sides of a third pinion. This pinion carries by means of its spindle the movable dial F, which is free to rise and fall, and to partake of the motion of the two racks, and to show by its pointer the combined motion of the two on the scales; this dial is guided by the long or differential rod shown affixed to its back;

the racks slide freely between guides affixed to the dial plate, which guides keep it steady laterally, while the long rod before mentioned prevents the plate from turning with the pinion. The tubes in which the stirrup couplings are placed prevent the steam or dust which may come from the glands and belt below from getting amongst the wheel work; the upper end of these tubes is covered with a disc, in the centre of which a square hole is filed to act as a guide to the long screwed rods, and to prevent them from turning. The marking of the dials has to be done experimentally, that is to say, the horse-power dial must be so scaled, the other two are divided out into equal parts, and are figured in such a way that should the one pointer move 10 deg. more and the other 10 deg. less, the resultant of the two numbers shown should be the same as before they had moved. To enable the central drum to show by diagram the horse-power, it is arranged to rise and fall with the central dial, the whole weight of these rising and falling parts being balanced by a counterweight and cord leading over a pulley mounted on ball bearings. A fourth pinion fixed on the spindle or arbor of the central pinion gearing into a rack, gives to that rack the combined motions of the other two racks. The same result may be obtained by a continuous metallic cord having the centre part made fast, and with three turns winding off and on a drum on the central spindle and a pulley on the paper drum carriage above, causing a vertical slide carrying the pencil to rise and fall, the vertical distance between the paper drum and the central dial arbor being maintained by a radius rod or frame, as with the rack arrangement. To provide for the rotary movement of the paper drum, it can be driven by a square shaft on which it slides, or a slotted shaft with feather, as used in self-acting lathes for traversing the saddle.

Professor R. H. Smith suggested that the use of aluminium for the conical roller of Mr. Henry Lea's integrating indicator might make it suitable for high speeds. He asked Professor Ripper to give information as to the amount of leakage past his oscillating and rotating valves. He said he had had no difficulty, on paying the proper price for them, in procuring steam gauges that read accurately when new-made or freshly adjusted; but after four to eight or nine months' continuous use on a boiler, he had found all coming under his notice to show a considerable error. Professor Ripper's instrument performed a most useful function, and was also scientifically very interesting. Professor Ripper had worked out in greater detail than had been previously done in published records the theoretical relations between distance averages and time averages on the assumption of uniform crank rotation, and the percentage differences between these two appeared to be smaller than he, the speaker, had hitherto imagined them to be. He regretted that the author's paper contained no attempt to explain the main theory of his instrument, namely, the fundamental proposition that it did actually give the true time average of the pressures. This seemed to be taken for granted, but it needed to be demonstrated as being at first sight by no means obvious. The theory appeared to him to be as follows, and it was interesting to note that the action really depended a great deal upon the mass of water filling the U-tube and the gauge tube. This mass and a portion of the metal mass of the gauge tube was free to move in either of two opposite directions. In one direction it was impelled by a continued series of more or less irregular impulses, in which the impelling force varied rapidly through a large range. In any given time, short or long, the momentum generated in the mass in this direction, by this series of impulses, was the time integral of the product of each force by the short time during which it acted, or $\int P\,dt$, where P is the varying steam pressure acting on the top of the water column. Therefore, the time average of the force P would be this total momentum, or integral, divided by the whole time t. But at the other end of this same movable mass was another force, due to the elastic spring of the gauge tube, impelling the mass in the opposite direction, and imparting to it opposite momentum also, in the same time, equal to a similar integral. But in this second integral, in virtue of the throttling, the impelling force was maintained very nearly constant, so that, assuming it as constant, the integral in this case was simply $S\,t$, where S was the constant spring force and t the whole time over which the integral was taken. But in the instrument this water and metal mass was, on the whole, carried in neither one nor the opposite direction; at the end of a minute or several minutes it had gained neither positive nor negative velocity and momentum. That is, the sum of $\int P\,t$ and $S\,t$ with their proper signs attached was zero, or $S = \frac{\int P\,t}{t}$ = time average of P. There were actually other forces besides the gauge tube spring force and the steam pressure hindering generation of momentum in either direction, namely, the frictional resistances to flow of water to and fro along the tube and through the throttles. But, in the first place, the throttling prevented such to-and-fro movement developing to any but the most minute extent, and therefore keeping the frictional and viscous resistances—which were proportional to a power between the first and second of the velocity—very low; and in the second and more important place, these fluid frictional resistances never absolutely prevented the development of motion in due time. That is, if there were the smallest want of balance between the other forces, then this unbalanced force would in course of time, although slowly in proportion to its small amount, produce integral motion in spite of viscous resistance. But the mass in question did not shift its mean position even after a very long time, and therefore there must be the above-described perfect balance of the two opposite integral impulses independently of frictional and viscous resistances such as were largely developed by the throttling.

In reply to what Professor Smith had said, Mr. Büdenberg remarked that pressure gauges could be had which, with proper care, would remain accurate for years. Their test gauges had been in use for some ten years, and they were still accurate. The gauge should be kept cool, and the fluctuations should not be too great. It was advisable, too, to let the motion of the tube itself be slight and have a high multiplying gear.

Mr. Henry Davey spoke of the use of throttling, and whilst admitting that when used skilfully it gave trustworthy results, he thought something better was needed. He was, with Professor Smith, sorry that no theory of the action had been given, and went on to show by diagrams that the indicator described by the author would be unsuitable for certain cases. He was also of opinion that if the conditions of working changed suddenly, as, say, from dry steam to wet steam, the results would be vitiated. He thought that some proper adjustment of the throttling was required.

Professor Pullen pointed out that in using a planimeter greater accuracy than within a pound pressure on the scale could not be secured, because with high-pressure springs the thickness of the line on the card was equivalent to about one pound. He thought that Professor Ripper's instrument would give results as accurate as that. He would like to know, however, if the instrument worked satisfactorily when variations from 10 to 15 per cent., due to the governor hunting, took place. He would also like to know what happened when the valves were unequally set, so that the power was not the same on each side of the piston. He thought such an indicator would be found useful on a locomotive, where the tube could be led into the cab.

Professor Ripper, in his reply, said that if the valves leak only a little the errors caused are unimportant; but the valves should be kept as tight as possible, especially on the steam side. In reply to Mr. Davey's objections, he observed that every instrument has its limitations, and in such a special case as Mr. Davey had instanced this indicator would not be suitable. He took the opportunity of pointing out the advantages of this type of indicator:—(1) On going into an engine-room one could see at once what the engines were doing by merely inspecting a dial. (2) In a compound or multiple expansion engine the distribution of the power between the cylinders could be seen at once. (3) Every steam engine has its best load—the load at which it can be worked most economically. In the college at Sheffield they have the rated load of the engine marked on the dial, and endeavour to keep the pointer as near to it as possible. (4) If there is anything wrong with the working of the engine it can be seen at a glance. (5) The valve setting can be checked by taking first one end of the cylinder and then the other. (6) For trial trips such an indicator might be used in conjunction with the ordinary indicator, and cards taken at very much longer intervals than they are now.

In reply to another speaker, he said that the pointer was always slightly on the move, enough to show that the apparatus was "alive," but no trouble was experienced in estimating its mean position. The meeting then terminated.

Our readers will probably be interested in another form of indicator, which we understand is being tried in America. It was briefly described by us on December 2nd last year. The following figures—4 and 5—will make the

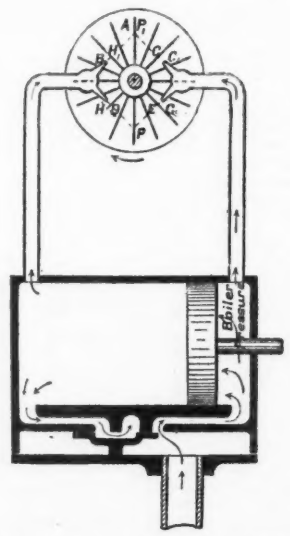


Fig. 4—DIAGRAM OF ATWOOD'S INDICATOR

ingenious device intelligible. Fig. 4 is a diagram of the arrangement. The indicator consists of a vane wheel A, and four nozzles B, C, D, and E, which are connected to the opposite ends of the cylinders. By a simple contrivance worked by the engine, only two opposite nozzles are open at the same time. Thus B and C can be open together, or D and C. Now as the full pressure is driving the vane wheel in one direction and the back pressure is resisting this motion, its resultant speed is proportional to the difference of the two pressures. It must be noted that from the arrangement of the parts the direction of rotation of the vane wheel is always in the same direction. The nozzles are closed by a pair of shutters which slide in front of them, and are worked by a tight rod from the engine. The indicating gear will be understood from Fig. 5. The vane wheel carries above it a second wheel called the turbine fan. The two are attached together and run on ball bearings. Above the fan wheel is another wheel with vanes, called the indicator fan. It is quite independent of the others, and its spindle carries the pointer. A light flat spiral spring tends to keep it in a normal position. It will be seen that the current of air created by the fan carries round the indicator wheel and to an amount proportional to the

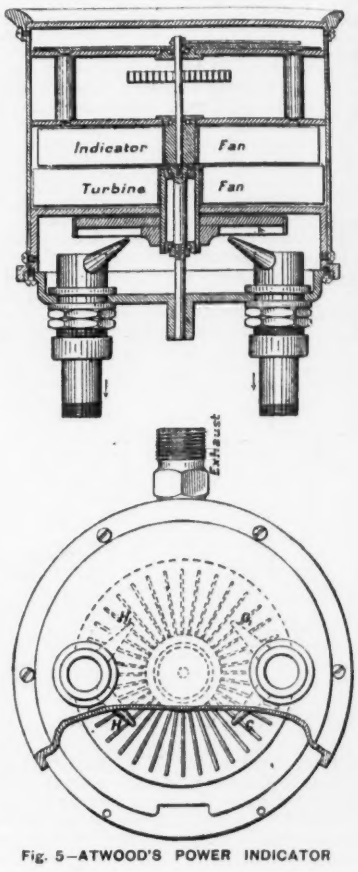


Fig. 5—ATWOOD'S POWER INDICATOR

speed of the former. We have no experience of the working of this indicator, but we have heard that it acts satisfactorily. It is certainly very ingenious. It is made by Mr. Atwood, 95, Liberty-street, New York.

WORKMEN'S COMPENSATION CASE.

December 2nd.—Court of Appeal.—Plaintiff, George Lloyd; defendants, Sugg and Co. This was an appeal from the decision of the Westminster County-court. The plaintiff, George Lloyd, was a smith in the employment of the defendants at their engineering works at Westminster. The plaintiff was at the time of the accident holding a flatter on the anvil for another workman to strike the flatter, when the hammerer by accident struck the shaft of the flatter and jarred the plaintiff's hand. In consequence the hand became swollen, and gout in the hand was brought on. The doctor who attended the plaintiff, and who was called as witness by the defendants, said that he had attended the plaintiff previous to the accident for gout in the hand and elbow, that the plaintiff had gouty diathesis, and that he thought the swollen hand was caused by gout brought on by the jar. The doctor's certificate stated that the plaintiff was suffering from a weak hand caused partially by the injury. The County-court Judge awarded the plaintiff 15s. a week, stating that the case came within the Act.

The defendants contended that the injury to the hand was not caused by the accident. There was no evidence that the injury was solely caused by the accident. The gout was the cause of the swollen hand.

The plaintiff's counsel was not called upon.

The Court dismissed the appeal.

LORD JUSTICE A. L. SMITH said that he desired to say that, as these appeals were solely upon questions of law and not upon questions of fact, it would be a great assistance to the Court if County-court Judges would certify particularly what their findings of fact were. In the present case the County-court Judge had only reported at the end of his notes that he had awarded the plaintiff 15s. a week, but the Court were told that he further said that the case came within the Act. The point now taken was that there was no evidence that the injury was solely caused by the accident. The evidence showed that the mis-hit by the hammerer jarred the plaintiff's hand. That mis-hit was an accident, and if it had broken the hand the case would have admittedly been within the Act. It was said that the injury to the hand was caused by the gout and not by the accident. The doctor's certificate stated that the plaintiff was suffering from a weak hand caused partially by the injury. Any one might have a weak hand. Was it to be said that in such a case as this only those with cast iron hands came within the Act? The present case seemed to him to be a perfectly clear case. The injury to the hand was caused by an accident, and the Act applied.

LORD JUSTICE COLLINS concurred. The case was a clear one. There was a jar to the workman's hand brought about by the hammerer hitting the rod and not the flat end of the flatter. The essential element of an accident causing injury existed. The Court must assume that the County-court Judge decided every question of fact necessary to support his decision in favour of the workman. It was urged in effect that the injury supervening upon the jar would not have been nearly so great had it not been for the gout. That seemed to him to be immaterial. There was the accident and the consequent injury, and the extent of the injury must depend upon the condition or the constitution of the person injured at the time of the accident. The principle always followed in cases where compensation had to be assessed for personal injuries caused by negligence, so far as related to the causes contributing to the disability, must be applied in cases under the Act of 1897. Take, for instance, the case of a delicate lady receiving a shock in a railway accident. The injury would be much greater to her than in the case of a lady in perfect health. In each case the Court had to deal with the then existing condition of the injured person to arrive at the ultimate result.

LORD JUSTICE VAUGHAN WILLIAMS agreed.

AMERICAN MACHINE TOOLS FOR ENGLAND

NILES TOOL WORKS COMPANY, HAMILTON, U.S.A., ENGINEERS

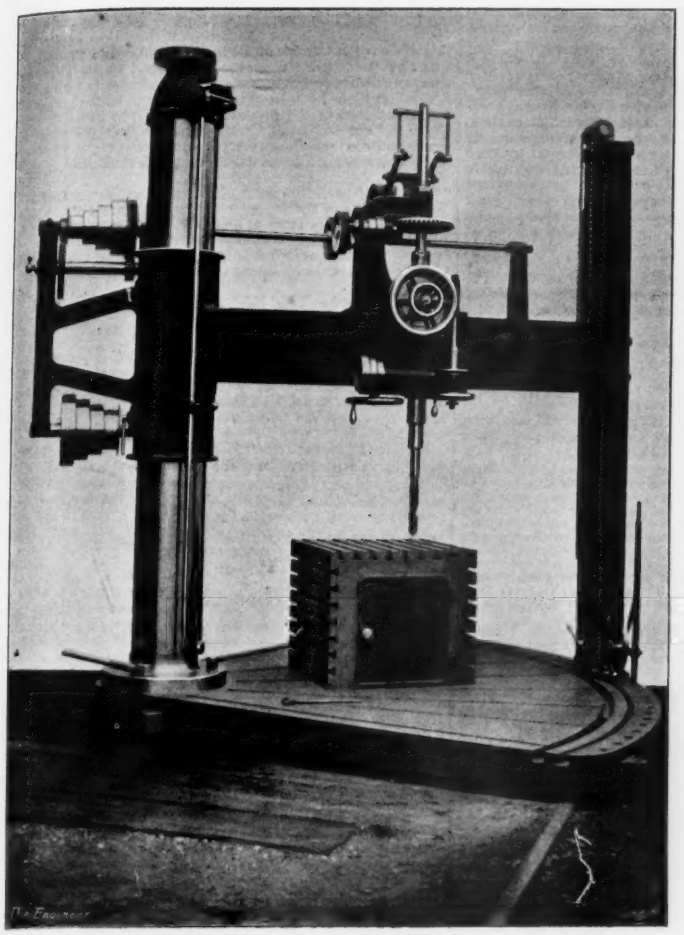


Fig. 1—RADIAL DRILLING MACHINE

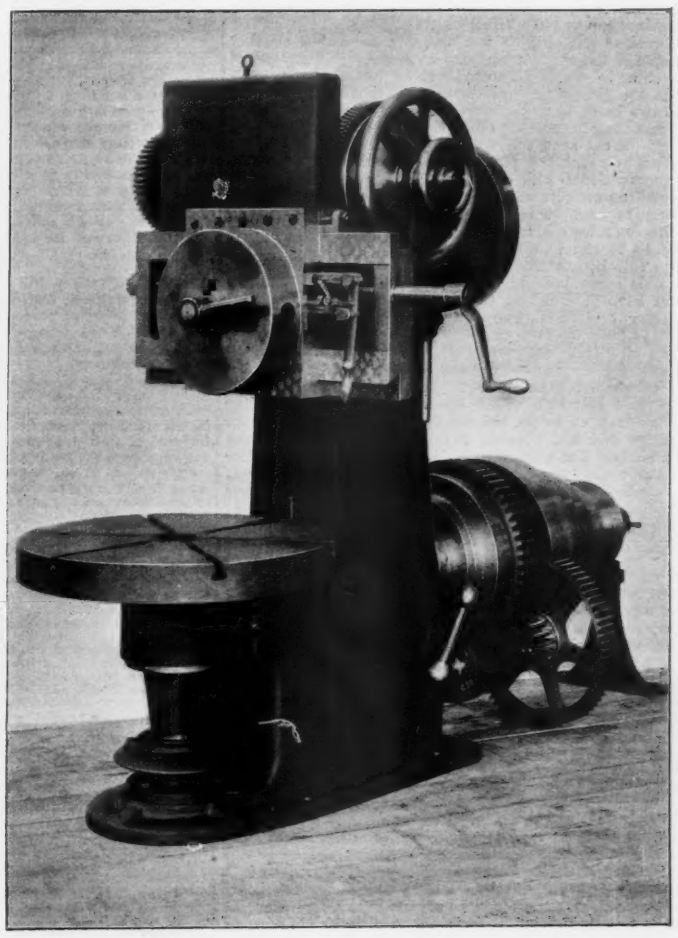


Fig. 2—VERTICAL TURRET BORING MACHINE

AMERICAN MACHINE TOOLS FOR ENGLISH WORKS.

By an American Engineer.

Many sharp criticisms have been made against American tools, a very common one being that they are too light for their work; but this is a sweeping criticism which is largely based on prejudice, and on what are now old-fashioned designs in the United States. As a matter of fact, American manufacturers of tools of this sort are undoubtedly quicker to introduce improvements in general design and in matters of detail—which latter are often the most important—than are the English manufacturers, and such tools are more efficient and have greater capacity in shops where their full efficiency can be developed without being limited by the unreasonable restrictions by which English users of machine tools have in the past been so tightly bound. The very fact of the great extent to which American tools are already being used, added to the fact that the English trade of the American makers is steadily increasing, serves to show that a mere general denunciation of these tools is certainly meaningless and baseless, and, as has before now been pointed out in The Engineer, the English makers might well devote more time to a consideration of the reasons for these facts, and of the possibilities of introducing improvements in their own machines. It is too well known that many English machine tools are built practically on the same lines as those of five, ten, or twenty years ago, and though certainly heavy enough, are clumsy, and have much of the weight and material in the wrong place. Of course not all American tools are good, and certainly not all English tools are bad; but without any undue praise of American tools or undue criticism of English tools, it may fairly be said that the matter is well worth the careful attention of both makers and users of machine tools. It cannot be disposed of by mere slurring remarks about "cheap and nasty" foreign tools, for none of your readers will believe that English engineers are buying extensively of American tools simply because they are cheap. This subject, like Banquo's ghost, will not "down," and must be faced.

I am sending you a number of photographs of machine tools now being supplied to English works by the Niles Tool Works Company, of Hamilton, U.S.A, which is one of the largest and best known firms—in America and in other countries—making a speciality of heavy machine tools. These views—reproduced above and on page 596—are a selection of a few recent machines shipped to England by this firm, and in view of the foregoing introductory remarks, it will be well for those of your readers who are interested in the design, manufacture, or use of machine tools to give special attention to the descriptions and illustrations. It may also be said that this attention should be given in a spirit of investigation, and not of mere superficial criticism.

Radial drilling machine, Fig. 1.—This machine is designed to save time, labour, and money in setting work. The work has merely to be set level, without the necessity of getting the hole centred under the point of a fixed drill, the operator easily and quickly moving the drill up to its work. It will work at any point and in any direction within a circle 14ft. in diameter. The main column is 9ft. high, machined all over, and on it slides a sleeve carrying a radial arm 7ft. long, the outer end of this arm sliding in a movable column, and supported by a counterweight suspended within this column. The foot of this column travels in and is clamped to a circular T slot in the table. The arm is raised and lowered by power, and when raised to its full height the end of the drill spindle is 6ft. 6in. above the base plate. The distance from the column to the drill spindle, in its vertical position, is 5ft. 9in., so that a hole can be drilled in the centre of a circle 11ft. 6in. in diameter, a reach which is beyond that of any ordinary drill press. The steel spindle is $2\frac{7}{8}$in. diameter, with quick-return movement, and the necessary traverse for deep holes. The feed is by power. The whole machine swings around a stationary sleeve, which has a bearing high up inside the main column.

The base of the machine is a heavy cast iron plate, turned, drilled, and having T slots. It is of quadrant shape, extending over one-fourth of the circle described by the swing of the arm, so that work may be clamped to floor plates if required. For small work there is a movable box table, which forms a cupboard for tools, and which may be set at any part of the base table. The driving power is applied by a vertical shaft from the countershaft to the gear at the top of the column, and is transmitted to the cones, whence it is again transmitted to the spindle by the horizontal shaft and two pairs of mitre gears. The head is moved along the arm by means of the horizontal screw. The driving cones have four steps, and are powerfully back-geared, giving eight changes of speed. The cones are very accessible, and any change of speed can be quickly effected. The countershaft is run at 120 revolutions per minute, and has two pulleys 16in. diameter, and 4in. wide on the face.

Vertical turret boring and turning machine, Fig. 2.—Tools for turning and boring work are among the most numerous in shop equipment, and I give an example of an American tool of this class now being introduced into England. The special feature of the particular tool shown in Fig. 2 is the turret head supplied with all the cutting tools necessary to perform and complete each operation without change, thus effecting a great saving in time. The heavy horizontal table is very convenient for setting the work, which can be done without temporary clamping. This table is supported on a spindle with large bearings. A lathe chuck can be attached to the table for regular work, and the top of the spindle can be arranged to support the lower end of the tool holder, if desired. The turret head has four holes to carry the drill, cutter bar, counter bore, and reamer, or any other combination of cutting tools suitable for the work, and its adjustments are so carefully made, and it can be operated so quickly, that a material reduction in time of performing the work can be effected, with an increase in the accuracy of the work. The quick return, the range of speeds and feeds, and the reduced expenses for repairs also tend to great economy in the work.

The hand-feed allows the working of very small holes, and by the use of a special tap holder or reversing pulleys, ordinary tapping can be done expeditiously. Pieces requiring to be faced can be finished with a wide cutter and hand feed. The feeds are positive, and designed for quick adjustment, and the range of speeds obtainable through the large cone, bevel pinion and rack, is sufficient for any general run of work.

The bed is substantially made and heavily braced, its shape being so designed as to offer the greatest resistance to the strains due to heavy cuts. The slide is large and securely carried in the frame, so that there can be no springing or "chattering." The spindle thrust is taken on an anti-friction bearing at the bottom of the bed, and an opening in the spindle permit borings to fall to the floor, the bearings being protected against dust, &c. The main bearing is independent, removing all wear from the bed and giving a minimum cost of repairs on the part subjected to the greatest wear. All gears are cut from the solid, and the wearing surfaces are accurately fitted. The machine has a swing of 30in., bores 14in. deep, has three feeds for drilling and boring, and five speed changes for a 4in. driving belt.

Horizontal boring and drilling machine, Fig. 3, *page* 596.—This machine is somewhat novel in style, and will bore to the centre of a 5ft. circle. Its working table is 6ft. long, supported by heavy screws, and elevated by power, a hand adjustment being also provided for a close setting of the work. The table carries a saddle and cross table with compound movements. At the end of the bed-plate is an adjustable yoke to support the outer end of the boring bar, and this also affords an additional support for the table, but can be removed when desired. The steel boring spindle is 4in. diameter, and has a traverse of 54in., obtained by two settings of the spindle, each of which gives an automatic traverse of 27in. A rapid hand movement is given by rack and pinion. Four changes of feed are effected by gearing operated by a clutch, the feeds being reversible. The driving cone has five steps for a $3\frac{1}{2}$in. belt, and is strongly back-geared, giving ten changes of speed to the boring spindle.

79-inch double driving-wheel lathe, Fig. 4.—This machine will take locomotive driving wheels up to 79in. in diameter, and it is fitted with two heads, face plates, carriages, &c., so that a pair of wheels mounted on their axles may be turned up at the same time. The face plates may be driven together or independently, as desired, and at the same or different speeds when wheels off their axles are being turned up. Ten changes of speed can be given to one face plate, and five to the other. All the gears, even the large gears for the face-plates, are accurately cut from the solid, and these large gears are bolted to the face plates, so that, in case of breakage, they may be renewed without removing the entire plate. The main spindles are of large diameter, carried in long and ample bearings, and each main spindle has an internal spindle, with sufficient length of traverse to allow of a pair of driving wheels being turned up with the crank pins in place. The feeds are automatic at all angles, and are operated by an overhead rock shaft driven from each main spindle. The range of feed is from $\frac{1}{16}$in. to $\frac{3}{8}$in. for turning and boring. The machine is designed for the heaviest class of work, and for the greatest convenience in handling. The front section of the bed is made of extra depth, so as to ensure strength at the point where the strain of the cut is imposed, and this also permits of the use of short and stiff tool posts, thus ensuring steadiness when making heavy cuts.

The machine may be fitted with crank-pin boring attachments, the boring spindle being very large, and being supported close to the work by a bearing on the inside of the face plate, which prevents the spindle from springing. A

quartering attachment may also be fitted to one or both headstocks, as required. The driving cone has five steps for a 6in. belt, and a heavy steel driving shaft transmits motion to the face plates. The main countershaft has two pulleys, 36in. diameter, with a 6¾in. face, and is run at 65 revolutions per minute. The countershaft for the quartering attachment has two pulleys, 12in. diameter, and 3in. wide on the face, and this is run at 140 revolutions per minute.

16-*inch double shaping machine, Fig.* 5.—This is another example of the modern tendency to increase the capacity of a machine by enabling two tools to be worked upon it independently. For many varieties of work a shaping machine with two heads is a special convenience, and this tool has two travelling heads, each saddle having a traverse extending beyond the centre of the bed, and being quickly adjusted in position by a rack and pinion. The machine has therefore practically double the capacity of a single-head machine, and on long work its use effects a decided saving of time in setting the work. Two driving cones are provided, making the heads entirely independent of one another, and allowing them to be run at different speeds. The bed is very deep and is 10ft. long, with a centre leg for support. The greatest available space between the cutting tools is 8ft. The two tables have independent elevating screws, giving a vertical adjustment of 18in. The cutter bars are 36in. long, with bearings 26in. by 7½in. on the saddle plates. They have a stroke of 16½in., with quick-return movements. The feeds are downward, crosswise, angular, and circular, all by power, and independent for each head. Each driving cone has four steps for a belt 3½in. wide. The countershaft runs at 150 revolutions per minute, and has tight and loose pulleys 16in. diameter and 5in. wide on the face. The makers supply with the machine a swivel vice and a self-feeding cone for circular work.

73-*inch boring and turning mill, Fig.* 6.—This massive machine will take in work 6ft. wide and 3ft. high under the tool-holders when the cross-rail is raised to the top of the uprights. The swings on the saddles traverse radially in a circle with a diameter of 73in. The countershaft runs at 175 revolutions per minute, and carries pulleys 18in. diameter, with a face of 4½in. The uprights or housings are of double-web or box section. The cross rail is also of box-girder form, with wide bearings, and is raised and lowered by power. The saddles are made right and left, so that they may be brought close together, and the right-hand saddle has a quick hand traverse by means of a rack and pinion. The driving cone has six steps for a 4in. belt, and is placed at the side of the machine, which is strongly back-geared, giving a wide range of speed. The cone transmits power through a pair of heavy cut bevel gears to an internal spur gear, which drives the table, an arrangement which ensures steadiness, and freedom from "chatter" or any lifting tendency. There is an annular bearing under the outer edge of the table, and when heavy pieces are to be worked the spindle step is relieved, and the table allowed to rest lightly on the outer bearing. When adjusted in this way the machine works as steadily as a heavy planer, and with the precision of a lathe. The spindle is unusually long, and rests on a steel step. Ample bearings are provided, and these can be adjusted for wear in such a way as to keep the spindle centered. The feeds are operated by a friction disc shown at the right of the bed. This has a range of $\frac{1}{32}$in. to $\frac{9}{16}$in. feed, and the feed can be varied instantly to any degree within its range. At the end of the rail is a pair of gears, by means of which the speed can be increased 100 per cent. without shifting the friction disc.

The boring bars are octagonal in section, and one of them is brought exactly central with the spindle. They are quickly handled by means of worm gearing, may be set at any angle, and may be fed in any direction independently of each other. They have a traverse of 42in. The tool-holders are steel forgings, arranged to hold the tools in any desired position, and may be removed and replaced by other tool-holders if desired. A special feature of this machine is the counterweighting or balancing of the bars, which is effected by the Niles patented system. As may be seen from the view on page 596, a single chain is attached at one end to an arm rigidly secured to the cross rail, while a similar arm at the other end of the rail carries a pulley, over which passes the weighted ends of the chain. There is a sheave on the face of each tool bar, and on each saddle are two sheaves straddling the bar, the chain passing over the saddle sheaves and under the tool bar sheaves. By this arrangement the counterbalance is perfect, no matter how much one or both of the tool bars are set over for angular work. As the saddle is moved along the rail, its sheaves simply run on the chain without any effect upon the counterbalance weight. When the swing is unbolted, so that it may be set over at an angle, the counterweight exerts no tendency to pull the swing around, a movement which might be dangerous to the operator. When a saddle nut is opened, and a swing quickly moved along by the ratchet lever, the counterweight has no tendency to resist the motion or to suddenly pull the swing along the rail, out of the control of the operator. With this system there is no overhead work to interfere with belting or the chains of the travelling cranes, and the counterweight only needs to be half the weight of the parts to be counterbalanced.

Chicago, November 7th, 1899.

Accidents to Railway Servants.—We understand that the Royal Commission on Accidents to Railway Servants expect to present their report in January.

Engineering Society, Glasgow University.—The annual dinner of the Glasgow University Engineering Society, was held on the evening of the 8th inst., in St. Enoch Station Hotel, Glasgow. Mr. Robert Caird, shipbuilder, Greenock, President of the Institution of Engineers and Shipbuilders in Scotland, presided, while Prof. Archibald Barr, of the Chair of Engineering, and Prof. Biles, of the Chair of Naval Architecture, acted as croupiers. Amongst other guests present were Professors Ferguson, Young, and Jack, of the University, and Watkinson of the Glasgow Technical College; Fleet Engineer Rees, of H.M.S. Benbow; Mr. Archibald Denny, Dumbarton, &c. &c. The toast of "The Navy, Army, and Reserve Forces," having been proposed by the chairman, Fleet Engineer Rees replied, and in a smart speech touched on the main incidents of the war at present raging in South Africa. The naval men, he said, were just aching to do their little bit. The captain of the Terrible, he declared, was getting the credit wrongly for the work now done for the first time of fitting up carriages for ships' guns so that they could be used for land service. When the facts became known it would be found that the invention of the new gun-carriage had been made by the engineer who was one of his subordinates, and from whom he had received a letter on the subject. He praised the work done by the marines, who were "soldier and sailor too," and showed how the victory at Graspan was really won by them. He thought, from sentimental reasons, that the Government should have accepted the offer of volunteers to serve in the Transvaal.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

AMERICAN LOCOMOTIVES AND PADDLE-WHEEL STEAMERS.

Sir,—The article on "The Locomotive Trade of Great Britain" is interesting and timely, but you might have laid greater stress upon the inability of "Great George-street" to design locomotives under commercial conditions. I have known an engineer of that conservative region who was in a position to make and criticise locomotive designs, but who knew nothing whatever of locomotive designing either from a technical or a manfacturing standpoint. He was a good civil engineer, but of mechanical engineering and shop work he was wholly ignorant. As to American practice, although a large proportion of the locomotives are built by contract, yet our locomotive superintendents are very far from being mere foremen. Most of them are men skilled as mechanical engineers—not merely as workmen—and are fully competent to design and superintend their engines. Many railways build and rebuild great numbers of engines, and have extensive shops for this purpose. The term "master mechanic" is a relic of the days when that position was the highest, but while it is retained for the divisional officials who are simply "mechanics," it is largely dying out for those superior officers who are something more than this. The more general title in this country now-a-days is "Superintendent of Motive Power" or "Superintendent of Motive Power and Machinery."

As to the way in which American firms obtain orders for locomotives, machinery, &c., I enclose you a clipping—quoted from a magazine article—which shows how an American firm dealing in railway material got the first chance at, and established friendly commercial relations with, the Chinese Eastern Railway—Trans-Siberian Railway extension. The footing thus gained has been followed up most energetically, and all sorts of machinery, tools, and supplies are being furnished from this country.

"The Chinese Eastern Railway has a peculiar and special interest for America. If it is building with a rapidity never before approached in railroad construction, the fact is largely due to American ingenuity, trustworthiness, and energy, for the tools, machinery, and materials with which the work is done are largely of American production; and the promptitude and skill with which these have been supplied, despite the great distance separating the United States and Manchuria, are not the least of the many wonders that have marked the whole enterprise. Naturally, we did not secure so eminent a part in the work without effort on our own part; and the story of how our ability to serve them was first brought convincingly to the attention of the builders of the line is nothing less than romantic.

"As the Trans-Siberian line drew nearer to the Pacific, Mr. Friede, a member of an American firm dealing in railway machinery and supplies, became convinced that, if the matter were properly managed a market for American railway machinery and materials could be found in eastern Siberia and Manchuria. Being thoroughly conversant with affairs in northern Asia, and also familiar with the Russian language, he decided to try to effect such a relation in those localities himself. In the spring of 1897, therefore, he set out for Vladivostock. On arriving there, however, he found that the engineers would not listen to what they regarded as his fabulous tales of American supremacy in the manufacture of tools and machinery, and the chief engineer was off in the wilds of Manchuria, somewhere on the Sungari River. The country was at that time unexplored by any white man, and engineers were setting out for the Sungari River to find and survey a route through Manchuria to the Siberian frontier. There were no means of following them, so Mr. Friede determined to go to Newchwang and proceed northward in the hope of meeting them. On reaching Newchwang he fitted out a cavalcade at his own expense, and then set off with his compass and instruments, to cross a section of the country never before entered by a white man.

"The greatest and strangest difficulties were encountered. Although Mr. Friede carried a passport viséd by the Viceroy himself in Peking, a formidable looking document of brilliant red, fully 3ft. long, he found the local officials extremely suspicious and fearful of him, and often in the villages and towns he came to it was difficult to get accommodation for himself and his party.

"Properly speaking, there were no roads, only rude, uncertain trails. As a rule, it was little use to ask for information about the way. Occasionally, if a proper bargain was struck, some marvellous adventurer, who had actually travelled twenty miles from home, would hazard some uncertain directions as far as to the next village. In the latter part of the journey there arose much anxiety regarding highwaymen, who were reported to abound and operate rather boldly in those parts. And once, when his cash wagon got away from him, Mr. Friede thought he had really fallen into their hands, but the thief proved to be the man who was driving the wagon, and it was soon recovered.

"In spite of all obstacles and hardships the party got through, and one day, at a point near the Sungari, a body of Russian engineers, intent on their surveying instruments, were astonished at hearing someone call out in excellent Russian, 'Is this engineer Iugowitch's surveying party?' They were dumbfounded at the sight of a stranger, and a white man, emerging from the forest, and could not believe that Mr. Friede had crossed the country they were about to penetrate. A friendship was at once struck up and the engineers proved more than willing to listen to arguments in favour of machinery and railway supplies that could reach them in weeks instead of months. Mr. Friede soon after began his homeward trip to inform American manufacturers that Siberia and Manchuria were open to them.

"With the arrival of the first invoice of American tools a new era began in railway construction in the Far East. It was found that the American pickaxes, hammers, and shovels were of better quality than those of European make, and were capable of heavier work. New orders for American material on a larger scale were given, and before the close of navigation in November, 1898, American rails, locomotives, hand cars, and even cross-ties were delivered in Central Manchuria, while at Vladivostock and Port Arthur supplies from America were arriving by the ship load. It was realised America could not only deliver better goods at a lower price than European countries, but deliver them in half the time. England, Belgium, and Germany were practically driven from the field in the first round. Orders were placed, not only for construction tools and material, but for American locomotives and equipment.

"All winter long belated material was sent from point to point over the ice on sledges, and early this spring the great final superhuman effort to complete the road commenced. Now, thoroughly equipped with American tools and every labour-saving device, the advance was rapid; but the Americanising process caused one difficulty, the first of its kind ever known in Siberia or Manchuria—a strike. Tens of thousands of coolies were at work along the line of road this spring when the American rock drill was introduced by Mr. Friede. The Manchus dropped their chisels, ceased chipping rock, and watched the drills thumping away hour after hour, apparently without motive power, drilling deep into the rock; they saw dynamite used, a sheet of flame burst forth, and the rock fly in great fragments—then they struck. Such performances were against all their traditions, and nothing could induce them to return to work. Even the Russian labourers caught the contagion, and joined the strike. The entire line was locked up and inactive for three days. However, the Cossacks did not go out with the strikers, and an adjustment was finally made, and the coolies returned to their labours. Now they enjoy nothing more than watching the drills picking away at the rocks, firmly believing that they work solely by the power of the white man's 'devil.'

"To round out the store of our own prosperity in this great enterprise the representatives sent around the world this last summer by Chief Engineer Iugowitch to find the best market for material, after spending several months in America, officially reported that of the millions yet to be used to complete the Chinese Eastern Railway more than 75 per cent. can be spent to the best advantage in the United States. Moreover, this last summer a contract for all the bridges still to be placed was given to an American firm, and they have now crossed the ocean and are on their way in sections overland to their various destinations in Siberia and Manchuria.

"From now on most of the material will go to Port Arthur after transhipment at Nagasaki, but sometimes a whole cargo of tools sails direct from New York, *viâ* the Suez Canal. With the approaching completion of the road the Russians are encouraging the establishment of a direct steamship line between San Francisco and the ports of Vladivostock and Port Arthur, for with the road completed a rich country of 10,000,000 population to start with, will be brought nearer our entire Western country than England or Germany. It is but 6000 miles from Portland to Port Arthur by water, and nearly twice as far from competing European rail."

You refer to the Hudson River steamers as burning wood for fuel, which is entirely erroneous. It is a case of the old confusion between these steamers and those of the Mississippi, the Missouri, and other western rivers. These latter are of very different design and construction, and have entirely different forms of engines and boilers. The hulls of the Hudson River steamers were, and are deep enough to hold the boilers, while on the western rivers the hulls had to be made shallow to provide for low water, shoals, bars, &c.

You say that the photograph of the Drew seems to show that a certain amount of sag had taken place. This is extremely doubtful, and the explanation of the appearance which has attracted your attention is that all these steamers are built with a very decided rise or sheer forward. This may be seen from the views of the other steamers, and also from the view of the Mary Powell, in The Engineer for December 9th, 1898, as well as from the drawings of the Puritan, in The Engineer of January 20th, 1899. As to the fire precautions on board the Bristol, it should be explained that this steamer was burned in December, 1888, while tied up at the wharf for the winter. Consequently she had no steam up and no pumps available, and only one or two watchmen to look after her.

The Fall River Line, to which this steamer belongs, runs all the year round, but in the summer there are two boats every week night, and one on Sundays, while after the tourist season is over the second boat and the Sunday trips are omitted, so that some of the steamers are laid up, as was the case with the Bristol, at the time of the fire.

There is no particular reason for comparing the old City of New York, and City of Boston, with the large steamers of the Hudson River. It would be more appropriate to compare them with the larger boats in their own waters—Long Island Sound. One reason for their inferior size is that they were for one of the shorter, and less important routes. Screw steamers are now in service on that route.

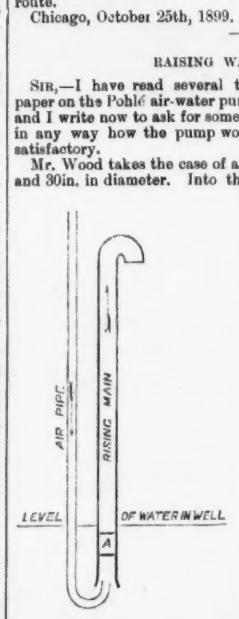
T. W. F. S. A.

Chicago, October 25th, 1899.

RAISING WATER BY AIR.

Sir,—I have read several times the abstract of Mr. Wood's paper on the Pohlé air-water pump, in your issue for December 1st, and I write now to ask for some explanation. I cannot understand in any way how the pump works on a large scale in a way to be satisfactory.

Mr. Wood takes the case of a rising main, with a head of 240ft. and 30in. in diameter. Into the bottom of this is delivered compressed air, at nearly 90 lb. pressure. This air, it seems, instead of rushing at once to the surface, forms what are very properly called air pistons, filling a tube 30in. in diameter. Will Mr. Wood explain how he succeeds in obtaining this result, in what way is the air delivered at the bottom of the rising main? I have always understood that the formation of bubbles the full diameter of a tube was a question of surface tension, and that nothing of the kind could be had, save in very small pipes. Let us now take Mr. Wood's word for it that such a bubble piston is produced at the bottom of the main.



In the diagram I have only shown one bubble piston at A, because I want to keep my question simple. Now we have a bubble A which contains air at 81 lb. pressure. This is exerted upwards and downwards. Why, then, does not the bubble expand downwards when there is only a head of a very few feet, I presume due to the water in the sump? Why will this bubble, subsequently as it rises, always expand upwards and not downwards?

The well-known water-tube boiler experiment shows that when air is blown in at the bottom of one leg of a U tube, water will rise in that leg and fall in the other. I can understand the same action taking place in the Pohlé pump, provided there is a good head in the sump, but if it is necessary to have such a head, then the utility of the pump must be greatly reduced. Suppose, for example, that the column in the rising main was two-thirds air and one-third water. Now, one-third of 240 is 80, and it seems to me that it would be necessary to have something like a head of 80ft. outside the rising main in order to get the pump to work. Is this so?

Again, I cannot understand how Mr. Wood has calculated efficiency. He says that a pump will give 80 to 90 per cent. from the air receiver; but, according to the description, the Pohlé pump works entirely without slip, and the whole of the energy in the compressed air is given out in expanding. What is the cause of the loss? Again, we are told that the consumption of fuel is but 1121b. of coal per horse-power per hour. Now it is very good coal that contains 15,000 British thermal units per pound. Mr. Wood allows, say, 1600 units to do 1,980,000 foot-pounds, but 1600 units only represent 1,241,600 foot-pounds.

I am sure Mr. Wood will much oblige many of your readers, who, like myself, are deeply interested in raising water, if he will give us through your columns the explanation for which I ask.

Shrewsbury, December 5th. Mining Engineer.

SHORE PROTECTION.

Sir,—Your issue of the 20th October contained an interesting paper read before the British Association, Section G, by the late Mr. Edward Case, in which it is stated that Case groynes were carried out at Dymchurch from the toe wall to low-water mark, spaced from 50ft. to 70ft. apart.

A good deal of interest is being taken here at present in the question whether similar groynes would be effective in the protection of the low-lying foreshores of this Colony, and I should be much obliged if some of your readers could say whether the above-named distances of placing the groynes apart is correct as printed, as the cost of that system of protection would be greatly increased if it were necessary to place the groynes so closely together.

C. W. Dickson, Col., Civil Engineer.

Public Works Department, Georgetown, Demerara, November 22nd.

THE VALVE GEAR OF THE NOORD BRABANT.

Sir,—I notice that the slide valves of Mr. Martin's engines are carefully balanced, and it is assumed that in consequence there will be no wear. It is a curious fact that wholly-balanced valves will wear rapidly, while those which are partially balanced will not. I say this as the result of very careful experiments carried out in conjunction with an engineer—since dead—who devoted much attention to the subject. We ground the valves, scraped them cold, scraped them hot—but it was no use. They wore, and would not keep tight. It would be interesting to have the experience of other engineers.

R. R.

Glasgow, December 12th.

WELSH TANK ENGINES.

Sir,—Allow me to correct a mistake which appears in the interesting account of the tank engines for the Barry and Port Talbot Railways in The Engineer for this week. Referring to the Barry engine, you say that the exhaust steam injector "is placed just behind the smoke-box." The injector is placed between the driving wheels and the trailing wheels, and can be easily seen in the photograph. It is the grease separator which is placed just behind the smoke-box.

E. Campbell Muir.

97, Ebury-street, S.W., December 9th.

(*For Continuation of Letters see page* 604.)

RAILWAY MATTERS.

A DAILY Pullman express service between Berlin, Buda Pesth, and Constantinople, will be established next summer, leaving Berlin at seven a.m., and arriving at Constantinople at ten minutes to ten a.m. on the third day.

THE Yorkshire Dales Railway from Skipton to Grassington, to be constructed at a cost of £600,000, is to be proceeded with at once, and opened for traffic in 1901. It is stated that the Midland Company will advance the whole of the loan capital.

THE Chicago and North Western Railway comprises 5077 miles of road. The main lines are laid with 80 lb. and 90 lb. rails having square joints. On parts of the Ashland Division across swampy ground, a writer in *Engineering News* says, the track can be seen to rise and fall, and the telegraph poles to sway to and fro, as the trains pass.

THE Cardiff Railway servants' dispute, affecting not only the Cardiff Railway but Rhymney, Barry, and the Taff Vale, it is inferred, was the subject of discussion at the Committee meeting of the Amalgamated Society, held in London on Tuesday, and it was agreed to make an offer to the railway companies to refer the questions in dispute to arbitration.

ACCORDING to the last annual report of the Japanese Railway Bureau, 472 miles of new line were opened during the year ended March 31st last. The total length of lines in operation was 3421 miles. The number of railway companies incorporated under former charters was fifty-eight, with a total capital of 238,775,000 yen, with 2652 miles of road in operation.

AT the last meeting of the Dartmouth Town Council the town clerk produced the amended plans of the proposed South Hams Light Railway. He explained that the line would run across the river by Kiln Gate, run along the river to Old Mill Creek, and then almost immediately enter a tunnel, through which it would run right under Dartmouth, coming out again above Ford.

THE Barrow-in-Furness tramways, about seven miles in length, have just been purchased by the British Electric Traction Company. Some time ago the Barrow Tramway Company offered the lines, engines, and cars to the Corporation for the sum of £22,000, but the latter declined to purchase them. Recently the affairs of the company have been in the hands of a liquidator appointed by the Court of Chancery.

AT a special meeting of the Warrington Town Council held last week it was decided to make application to the Board of Trade for sanction to construct and work tramways in the borough. The first tramway proposed to be laid down was from the borough through Wilderspool to Stockton Heath, and in all probability they would be electric tramways. The expenditure of the scheme is estimated at £170,000.

LAST Friday about fifty students of the Institution of Civil Engineers made an underground excursion for the purpose of inspecting the boring operation in connection with the construction of the Baker-street and Waterloo Electric Railway. Splitting up into several parties, the students descended at different points where tunnelling is in progress, and were conducted over the workings by members of the engineering department.

ON Thursday night last week a serious accident occurred on the Caledonian Railway, near Dunblane. A train loaded with cattle from Perth for London parted by the breaking of a coupling. The front portion went on, but the signals being against it, it had to draw up. The rear portion then came on at great speed, and dashed into the standing portion, working great havoc. A number of cattle were killed, and all traffic was stopped for some hours.

A RUN of five miles in three minutes, or at the rate of 100 miles per hour, is said to have been recorded lately on the Lake Shore and Michigan Southern Railroad. Engine No. 601 hauled eight passenger and baggage cars; the train left Buffalo 59 minutes late, and ran into Cleveland two minutes ahead of time, thus making up 61 minutes lost time in 185 miles. Only three station stops were made, and the engine slowed down seven times for crossings.

NEGOTIATIONS with the Mexican Government to take over the Isthmus of Tehuantepec Railway on a fifty years' lease have recently been completed by Sir Weetman Pearson, of the firm of S. Pearson and Son. The railway is 180 miles long, and was completed as recently as 1895 at a cost of 30,000,000 Mexican dollars. Besides reconstructing the railway, Sir Weetman has undertaken to construct two harbours at either end of the railway, which will, when complete, shorten and facilitate the journey to the East. The harbours alone are to cost over 10,000,000 Mexican dollars.

THE application of power brakes and automatic couplings in the United States, according to the latest report of the Interstate Commerce Commission, stands as follows:—Out of a total of 9956 passenger locomotives, 9845 are fitted with train brake apparatus, and out of a total of 33,595 passenger cars 33,149 were so equipped at the end of June, 1898. Of the passenger locomotives 5105 had automatic couplings and 32,697 passenger cars were thus equipped. In freight service 19,414 out of a total of 20,627 locomotives had train brakes and 6229 had automatic couplings. Out of 1,248,826 freight cars, 567,409 had train brakes and 851,533 had automatic couplings.

THE Irish mail train met with a mishap last Friday when passing through Norton Bridge, between Madeley and Stafford. It appears that a bale of cotton had fallen from a preceding train, and this caused part of the mail train to leave the metals. The coaches were overturned on to the up goods line, and a goods train coming along dashed into them. The tender of the goods train became separated from the locomotive, and dragged several wagons along with it for some distance. Both the driver and fireman of the goods train were thrown off their engine and rendered insensible, and the engine itself was wrecked and overturned. One person was killed, and several injured.

ON Saturday evening a serious accident occurred on the new Metropolitan Railway works below the Champs Elysées, Paris. At the Place de l'Etoile, the Vincennes-porte Maillot and Etoile-Trocadero tunnels run one above the other, and it is supposed that owing to the recent heavy rains, portions of the masonry work became undermined, and for a considerable distance the tunnel and roadway caved in. The workmen escaped, but two watchmen who were on duty upon the surface dropped into the chasm which was created and were seriously injured. The earth gave way for a space of fully twenty-five yards, carrying with it ten trees and two lamp-posts. The damage to the works will not delay the opening of the new underground railway next spring.

THE Runcorn Urban District Council have had before them a scheme of electric tramways propounded by Bennett and Ward Thomas, electrical engineers, Manchester. It is proposed to run the ordinary trolley system of electric tramways, from Weston to Warrington, passing through Runcorn, Norton, Acton Grange, Moore, and Lower Walton. When occasion requires an additional car for goods would be attached to the tramcars. For a radius of two miles from Runcorn the Runcorn Urban Council would have the privilege of supplying the electric current at a suitable price. The promoters asked the Council to support an application, under the Light Railways Act, to the Board of Trade, for permission to promote such a scheme, and this was decided upon, subject to satisfactory arrangements being made as to the repair of streets and other matters.

NOTES AND MEMORANDA.

THE horses of the Scots Greys now at the seat of war have been dyed khaki colour, to render them less visible to the enemy.

THE President of the Local Government Board has appointed Mr. Charles Per.in, M. Inst. C.E., Water Examiner for the purposes of Section 36 of the Metropolis Water Act, 1871.

IN the month of October 2669 vessels, measuring 385,176 register tons, used the North Sea and Baltic Canal, against 2436 vessels and 330,843 tons in the same month last year. The dues collected amounted to 209,211 marks, against 173,192 marks.

A METHOD of thawing water pipes by electricity has been put to the test in Canada. Alternating current at a pressure of 20 volts to 50 volts is used, obtained from a portable transformer connected with the street mains; a current of 200 to 400 amperes is passed through the frozen pipe until the water flows freely, which usually takes place in a few minutes.

DURING November Scotch shipbuilders launched 27 vessels, of 42,626 tons gross, against 27 vessels, of 35,870 gross tons, in October; and 19 vessels, of 31,213 tons gross, in November last year. For the year so far there have been launched in Scotland 310 vessels, of about 446,022 tons gross, as compared with 409,948 tons in the corresponding period of last year, 298,207 tons gross in 1897, 366,221 tons gross in 1896, and 349,635 tons gross in 1895.

GOLD is said to have been found in South African coal. In character the gold is said to be exceedingly fine, but visible, on close inspection, thickly peppered through the coal. The coal contains iron pyrites, and it is thought most likely that the pyrites, in contact with the coal, deposited the gold from solutions which had found their way up the dyke fissures, the gold having most likely been dissolved out of underlying auriferous strata.

THE British Consul at Odessa, in a report issued recently, states that cycles of English make are held in high esteem in his district, but are undersold by American machines, which have many of the parts cast that in English machines are turned, and can be sold about 40 per cent. cheaper. German cycles, he adds, have a good reputation for durability, and consequently, although but little cheaper than English machines, have a fair sale.

THE British Consul at Theodosia states that the Russian Government are desirous that a dry dock should be constructed in one of the Black Sea ports capable of accommodating the largest steamers in the Russian mercantile marine. It is stated that the Government would prefer that this undertaking should be taken up by a private firm or company, and the concession would be given to any private firm that could guarantee that the undertaking would be carried out.

A PROJECT is said to be on foot which involves the raising of Loch Doon by 20ft., and converting the waters of Nees Glen into a source of energy for the driving of dynamos and the operating of electricity. The scheme consists in the construction of a light railway, which is to run into the heart of the mineral districts of Scotland. The scheme has been brought about chiefly by the finding of ironstone, lead, &c., round about the upper end of Loch Doon and elsewhere in the district.

AT a meeting of the Manchester Section of the Society of Chemical Industry held recently, Mr. T. Aspinall read a paper on "The Oxidation of Organic Matter by Chlorine," in which he described some experiments he had made on the use of chlorine in sewage works, and in purifying sewage effluents. In the discussion which followed, the process was condemned by certain members on account of the excessive cost, but the author stated that the chlorine could be obtained as a by-product from chemical works.

AT a meeting of the Leeds Sewerage Committee held last week, it was stated that on the whole the experiments in the bacteriological treatment of the city's sewage at Knostrop are proving satisfactory. The constituents of the sewage have by this time been definitely ascertained, and the only constituent which defies the bacteria appears to be a certain chemical effluent. As one of the principal sources of this form of pollution has now been traced, it is hoped that means will soon be discovered to deal with it effectively.

THE new United States battleship Kentucky attained a speed of 16·867 knots on her trial trip. The Kentucky's record somewhat exceeds that made by her sister vessel, the Kearsarge, and it is expected that when the tidal allowance has been calculated, a speed of fully 17 knots will have been made. The engines are said to have worked beautifully, averaging in revolutions about 115, with a steam pressure ranging from 160 lb. to 180 lb. There was no noticeable vibration. The Kentucky was built by the Newport News Company.

THE deputation from the proposed Birmingham University, which was appointed to visit the United States and Canada to inquire into the educational system in vogue there, have returned. They visited Cornell University, the Massachusetts Institute of Technology at Boston, the M'Gill University at Montreal, and other leading colleges and schools. The deputation will report the result of their investigations, but it is understood that they are of opinion that though there is much to be learnt from America on education generally, English Universities have many advantages in which they are deficient.

LAST month English shipbuilders launched 24 steamers, of about 76,494 tons gross, against 29 vessels, of about 69,194 tons gross in October; 26 vessels, of 72,604 tons, in November last year; and 14 vessels, of 34,681 tons, in November, 1897. For the eleven months English shipbuilders have now launched 277 vessels, of 780,148 tons gross, as compared with 311 vessels, of 780,315 tons gross, in the corresponding period of last year, and 530,030 tons gross in 1897. During the eleven months there have been launched in the United Kingdom 598 vessels, of 1,323,665 tons gross, as against 653 vessels, of about 1,293,563 tons for the corresponding period last year.

IN an article which appeared in a German technical journal by Messrs. L. Holborn and A. Day, on gas thermometers for high temperatures the authors state their preference for platino-iridium as a material for use in the manufacture of the vessel, for the following reasons:—Hydrogen passes freely through incandescent platinum, but nitrogen does not, and the nitrogen pyrometer is reliable up to 1300 deg. The porcelain cylinder suffers under various drawbacks. It is not gastight unless it is glazed, and the glaze begins to melt at 1100 deg. At 1450 deg. the porcelain itself softens, and the vessel is filled with vapour given off by the glaze.

A LIST of guns in possession of the Boers has been published on what is said to be trustworthy authority by the *National Zeitung*. According to this account, the Boers have eight 7·5 cm. Krupp guns, sixteen 7·5 cm. Creusot guns, eight or nine Maxim-Nordenfelt field guns, twenty-four 3·7 cm. automatic Maxim guns, eight 12 cm. field howitzers—four from Krupp and four from Creusot—four 3·7 cm. Krupp mountain guns, four 15·5 cm. Creusot guns. In all, with old guns, the Boers possess some eighty or ninety pieces of artillery. During recent years the Boers are said to have bought 40,000 Mauser rifles, and 25,000,000 cartridges, as well as a large number of Martini-Henry rifles.

MISCELLANEA.

THE ninth annual dinner of the officials and foremen employed in the works of John Fowler and Co., Limited, Leeds, was held at the Great Northern Railway Station Hotel, Leeds, on Saturday.

HALF of the rock on which the Russian ironclad Grand Admiral Apraxine recently struck, during a snowstorm off the island of Gothland, has been removed by blasting, and the vessel's hull has been found to be undamaged.

THE American liner New York has gone into dry dock at Newport News for her annual overhauling, and is not billed to sail from New York again until 3rd January, after which the St. Louis and St. Paul will be overhauled, probably at Southampton.

BRITISH firms have hitherto supplied the fire engines for most of the principal Russian towns, but in Odessa Swedish manufacturers have recently got a foothold. The engines made in Sweden are said to be 30 per cent. cheaper than those made in either this country or Germany.

OWING, it is alleged, to differences between Mr. Carnegie and Mr. Frick, the latter has resigned his official connection with the Carnegie Company, and the report that he will sell his interests to his old partner and start another company of equal magnitude is based upon this fact.

A DEPUTATION from the Rivers Committee of the Manchester Corporation on Monday waited upon the Mersey and Irwell Joint Committee for the purpose of discussing the present position of the Manchester sewage disposal question. We understand that no decision of a definite character was arrived at.

AT the monthly meeting of the Hyde Town Council held on Monday, the borough surveyor submitted plans of the proposed new sewage tanks and filters, and the chairman and borough surveyor were empowered to obtain the opinion of Mr. Dibdin and Mr. Scudder as to the proposed scheme and plans.

THE German Emperor has raised Dr. Georg Siemens, head of the Deutsche Bank, and cousin to the late Sir William Siemens and Herr Werner von Siemens, who was the founder of Siemens and Halske, to the rank of Noble, in recognition of his success in securing the Baghdad railway concession for Germans.

A PAMPHLET on the hardware trade in Canada has recently been published by the *Ironmonger*. It consists of articles reprinted from that journal, and written by an expert sent to Canada last year to investigate the working of the preferential tariff, and the prospects of trade in British hardware in the Dominion.

AT the commencement of November, thirty-six out of the forty existing blast furnaces in Belgium were in operation—sixteen in the Charleroi district, fourteen in the Liège district, and six in the Luxemburg district. Of the furnaces in operation, the output per twenty-four hours is ten 905 tons of forge pig, four 295 tons of foundry pig, and twenty-two 2180 tons of steel pig.

THE Bolton Streets Committee on Monday recommended the appointment of Mr. A. L. Morgan, A.M.I.C.E., deputy engineer for the borough of St. Helens, to the post of borough engineer for the Bolton Corporation. The salary is £600 per annum. Mr. W. H. Brown is promoted to be assistant borough surveyor, and Mr. Brockbank, the present surveyor, becomes consulting engineer.

ON Wednesday evening, the 29th ult., Sir John Gorst presented to Sir John Donelly, the late head of the South Kensington Museum, a testimonial, which had been subscribed for by some 500 former colleagues of Sir John Donelly's. The testimonial took the form of a silver salver, a set of library furniture, a collection of books of reference, a Zeiss binocular, and a diamond brooch for Lady Donelly. Sir John Donelly had been connected with the Department for forty years.

THE screw troopship Tyne went ashore on Bembridge Ledge, at the eastern end of the Isle of Wight during a fog on Thursday, the 7th inst., and had a narrow escape of becoming a total wreck. The trooper, which had on board new crews for the Polyphemus and Imogene, and also ratings for other ships belonging to the Mediterranian Squadron, left Sheerness on Wednesday, and was due at Portsmouth on Thursday. She was subsequently got off and taken to Spithead, whence, after undergoing repairs, she sailed on Tuesday.

THE General Purposes Committee of the Worsley District Council have passed a resolution approving of the proposals of the South Lancashire Tramways Company to construct electric tramways from the terminus of the St. Helens tramway system, through Ashton-in-Makerfield, to Newton-in-Makerfield, Golborne, Abram, Wigan, Newton, Earlestown, Leigh, Atherton, Bolton, Tyldesley, Worsley, and Little Hulton, to Swinton. The Council will support the scheme, subject to such modifications and terms as to the arrangement of such provisions as it may think necessary in the interests of the district.

AT a meeting of the Shrewsbury Town Council held on Monday a report was presented by the Water Committee relative to a scheme prepared by Messrs. Taylor, Sons, and Santo Crimp. The gathering ground is situated at Batchott, on the Shrewsbury side of the Stretton Hills. Its area is 2040 acres, and the supply is to be sufficient for a population of 35,000, at thirty gallons per head per day. The water would flow by gravitation from a capacious storage reservoir to filter beds at Bayston Hill, and then on to the town, three miles away. The estimated cost is £155,000, the estimated expenditure £7601, and the estimated receipts £119 over that. The matter has been submitted to the Financial Committee.

RETURNS to hand of the shipbuilding work of the year now drawing to a close show that in the yards of the lower reaches of the Clyde—including Dumbarton, Port Glasgow, and Greenock—the twelve months aggregate will reach 220,000 tons gross, made up by the contributions of thirteen firms. The highest figure is, as usual, reached by Messrs. Russell and Co., whose output will be close on 52,000 tons gross register. Next place is taken by Messrs. Denny and Bros., Dumbarton, with 31,300 tons; next by Messrs. Hamilton and Co., Port Glasgow, with 25,865 tons; and next by Messrs. A. McMillan and Son, Dumbarton, with 21,273 tons; Messrs. Scott and Co., Greenock, follow with 20,544 tons, made up by four vessels only; next Messrs. Caird and Co., with 14,036 tons, followed closely by Messrs. Rodger and Co., and Messrs. Duncan and Co. The remaining firms have outputs below 8000 tons.

AT a meeting of the Salford Town Council held last week a resolution was adopted approving of plans and estimates for the whole of the machinery, plant, and distributing mains in connection with the new electricity generating station, amounting to £335,783, and sanctioning the making of application to the Local Government Board for power to borrow this sum. Mr. Haworth, chairman of the Electricity Committee, said that in order to expedite matters the Local Government Board had promised to hold an inquiry into the matter a week hence, in the event of the resolution being adopted. A good plot of land in Pendleton, bounded on one side by the railway and on the other side by the canal, had been obtained from the Highways Committee of the Corporation. The present generating station was of 660-horse power, and the new one would be of 10,000-horse power.

AMERICAN MACHINE TOOLS FOR ENGLISH WORKS

(*For description see page 593*)

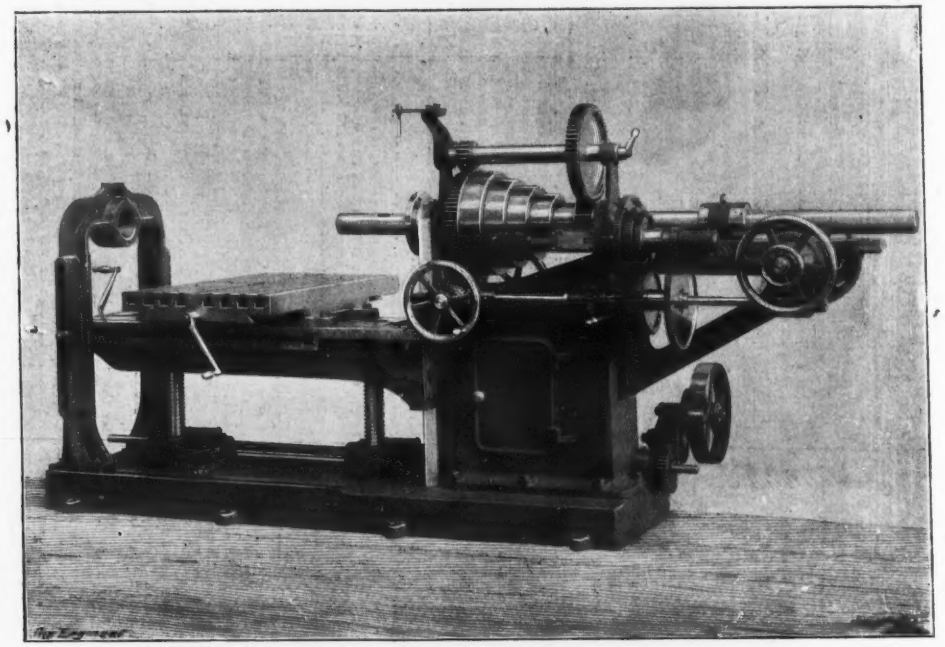


Fig. 3—HORIZONTAL BORING MACHINE

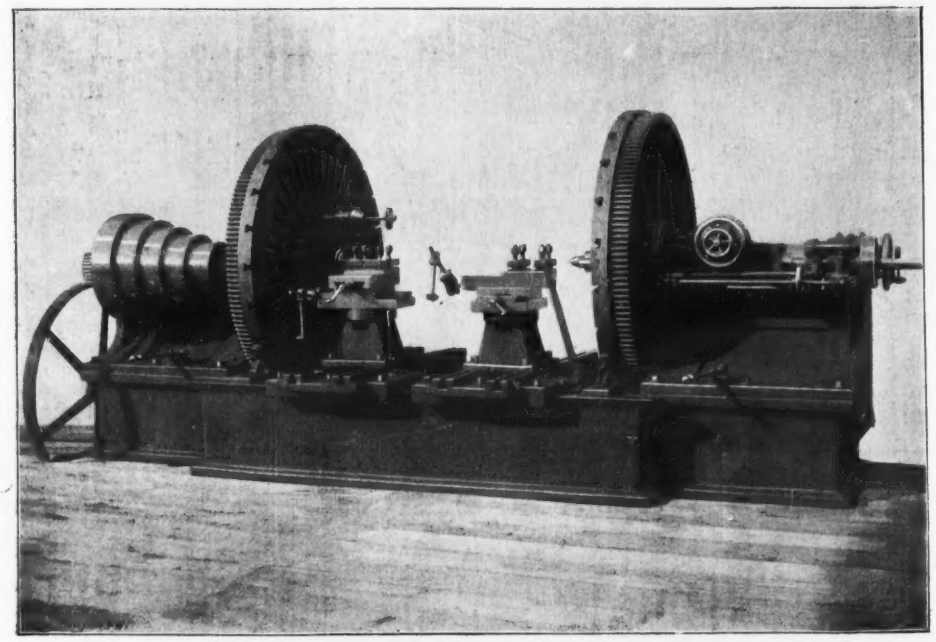


Fig. 4—79in. DOUBLE WHEEL LATHE

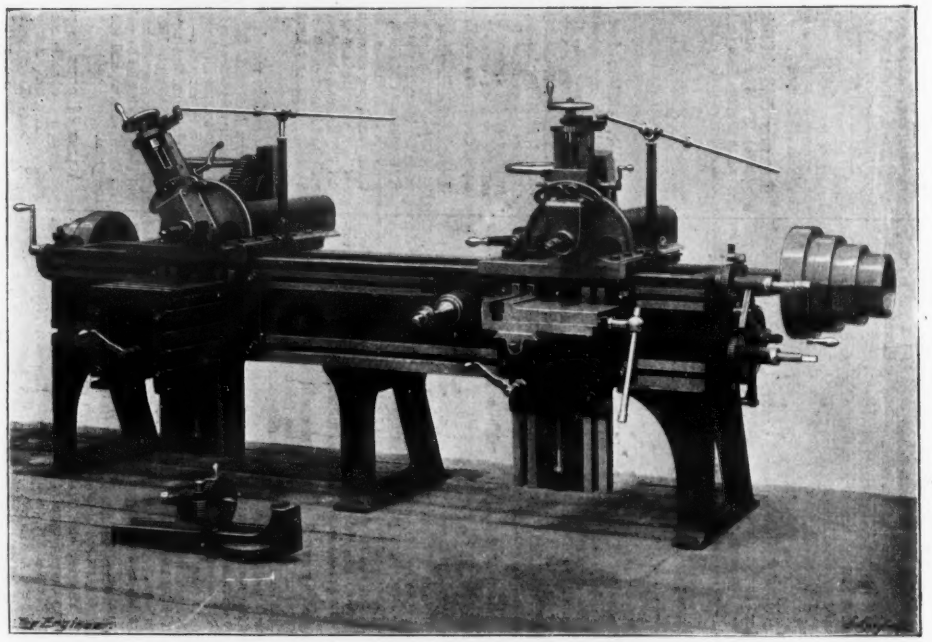


Fig 5—16in. DOUBLE SHAPING MACHINE

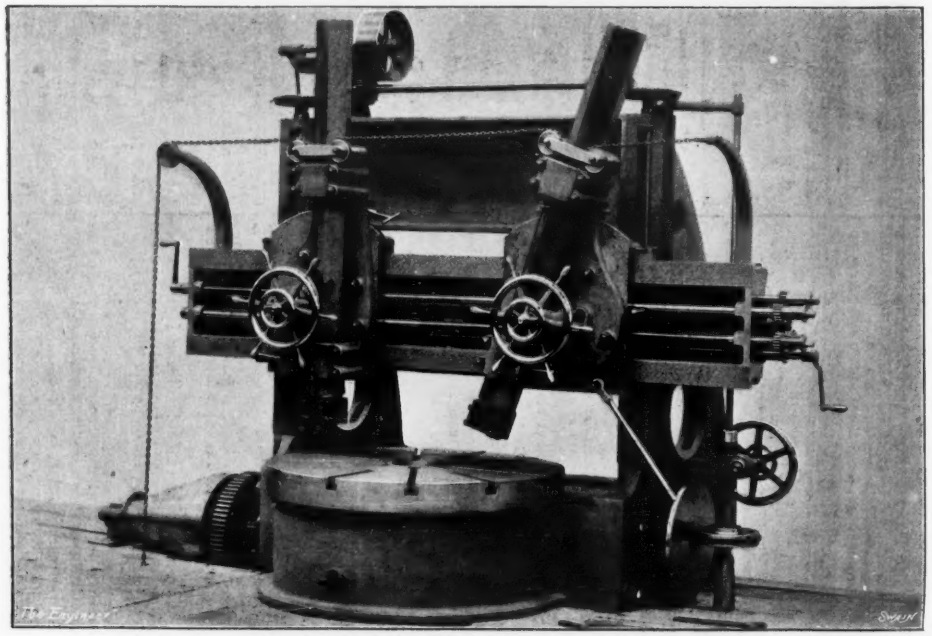
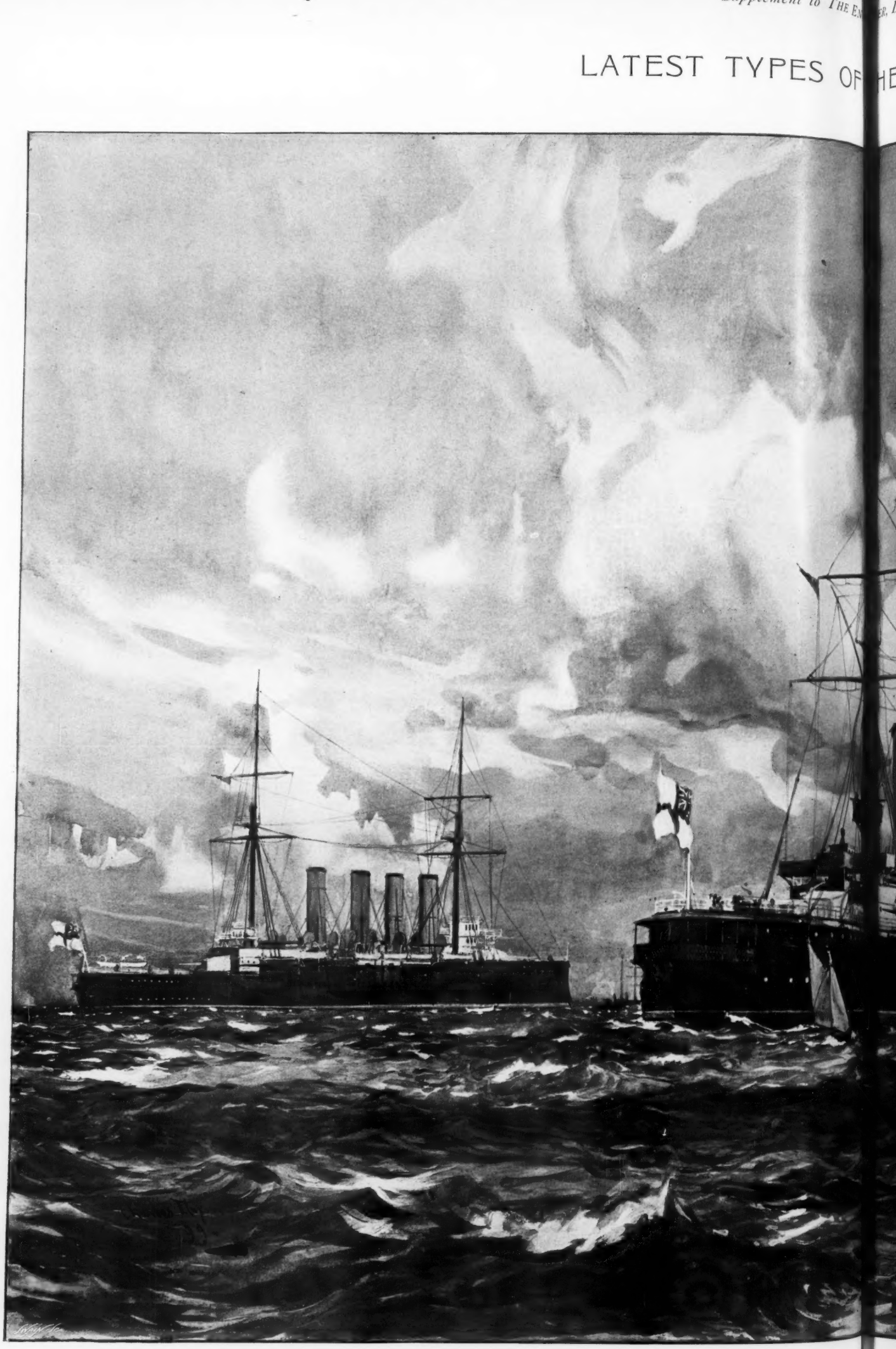


Fig. 6—73in. BORING AND TURNING MILL

Fig 5—16in. DOUBLE SHAPING MACHINE

Fig.6—73in. BORING AND TURNING MILL

LATEST TYPES OF ...HE



H.M.S. DRAKE.

CRUISER.

H.M.S. FOR... DA...

BATTLES...

[illegible] OF HE BRITISH FLEET.

[illegible]ORMIDABLE.

H.M.S. ALBATROSS.

TORPEDO BOAT DESTROYER.

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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*** *With this week's number is issued a Two-page Coloured Supplement of Latest Types of the British Fleet. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. I. (Devonport).—We shall be happy to give you all the information we can if you will write to us full particulars.

C. W. L. (Thornhill Lees).—We should suggest that you should apply to Mr. Robert R. Schmidt, 141, Potsdamer-trasse W. G., Berlin.

J. U. (Birmingham).—What you illustrate is simply an improved Prony brake, with a strap or a rope instead of wood blocks. The stress on the shackle at the top has no other effect than tightening the belt to give the necessary grip on the pulley. You will see on reflection that the stress due to the shackle passes directly through the centre of the pulley, and can have no moment of resisting effort.

J. B. B. (Edinburgh).—It is difficult to obtain any exact information as to when the Royal Commission on Sewage Disposal will present their report. We gather, however, that experts have been appointed to make certain investigations for the Commission, and these gentlemen reported, some six weeks ago, that it would not be possible for them to present their report for some eighteen months. It is improbable, therefore, that the report of the Commission is to be looked for till after this time has elapsed.

G. A. W. (Deansgate).—The highest pressures are used in the Navy with water-tube boilers; 500 lb. in the boilers, reduced to 250 lb. in the engines. The highest pressures used in electric light work are 160 lb. to 200 lb. For mill engines 80 lb. to 120 lb. are the usual pressures; in a few cases 150 lb. It is quite impossible to say what are the superheated steam temperatures used. Superheated steam is but little employed, because of its destructive effects on the liners of cylinders. It is quite inadmissible with slide valves. It is impossible to maintain an even temperature; about 600 deg. is the maximum safe temperature. In marine engine work no oil is put into the cylinders, except what finds its way in on the piston-rods. Oil in the cylinders spells ruin to the boilers. One of the drawbacks to the use of superheated steam is that oil must be put into the cylinders. A mineral oil with a very high boiling point is used.

MEETINGS NEXT WEEK.

LIVERPOOL SELF-PROPELLED TRAFFIC ASSOCIATION (BEING THE LOCAL CENTRE OF THE AUTOMOBILE CLUB).—Tuesday, December 19th, at 7.45 to 10 p.m., at the Liverpool Royal Institution. Presentation of the Judge's Report on the 1899 Trials of Motor Vehicles for Heavy Traffic.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, December 20th, at 7.30 p.m., at the Institution of Civil Engineers, Great George-street, Westminster. Papers, "The Climatic Conditions necessary for the Propagation and Spread of Plague," by Mr. Baldwin Latham, M. Inst. C.E.; "Note on a Remarkable Dust Haze experienced at Teneriffe, Canary Islands, February, 1898," by Mr. Robert H. Scott, D.Sc., F.R.S.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 19th, at 8 p.m., Ordinary Meeting. Paper to be discussed, "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc. M. Inst. C.E. Papers to be read, "The Purification of Water after its use in Manufactories," by Mr. Reginald A. Tatton, M. Inst. C.E.; "Experiments on the Purification of Waste Water from Factories," by Mr. W. O. F. Meade-King, M. Inst. C.E.—Thursday, December 21st, at 2 p.m., students' Visit to the Generating Station of the Westminster Electricity Corporation, and subsequently to the Works of the Shingleton Ice Company, Exeleston-place, S.W.

THE ENGINEER.

DECEMBER 15, 1899.

THE GERMAN BAGDAD RAILWAY.

THE concession for constructing the long-talked-of line of railway along the Valley of the Euphrates recently obtained by the Anatolian Railway Company, which represents the Deutsche Bank, is regarded by almost the entire Russian Press as a signal defeat of Great Britain's political aims, and also as the first note of the struggle that is destined in time to oust Great Britain from the paramount position which she has so long enjoyed in the commerce of the Persian Gulf and the adjacent regions. However, amid the chorus of approval the *Bourse Gazette* of St. Petersburg complains that the Power which, under the leadership of Bismarck, refused to sacrifice a single Pomeranian grenadier on behalf of the Eastern Question, will now become practically the master of the position in Turkey and Asia Minor. Such a complaint amounts to a confession that the veil has now been removed from Russian eyes, as it at length becomes apparent that German commercial enterprise has been gradually and silently leading up to a grand climax in the shape of obtaining the railway concession in question, and thereby ultimately getting Mesopotamia into its own hands. While the rest of Europe has been content to wrangle more or less at intervals over the inheritance of the "Sick Man," Germany, in the opinion of the *Bourse Gazette*, has quietly stepped in and annexed it.

The three Powers most nearly concerned in the future of Asia Minor are Great Britain, Russia, and Germany. Apart from the fact that this long-neglected territory offers a most remunerative field for commercial enterprise on the part of Great Britain, its advantages to us from a strategic point of view are perhaps of greater importance. A British line of railway from Alexandretta in Northern Palestine to Bagdad, and thence to Basra and to Kuweit on the Persian Gulf in North-Eastern Arabia, would not only form a great protection against any future invasion of the Syrian Desert, but it would at the same time bring India within reach of England by a combined land and sea route which would mean a saving of several days, and Great Britain would be incontestably the paramount Power on the Persian Gulf. Moreover, almost the whole of the shipping industry in the Persian Gulf is at this moment in the hands of British firms. Thus, the interests of Great Britain directly involved, both as regards India and British trade, unite to make it imperative that these interests shall be protected to the uttermost, and that the natural highway to India shall not be menaced.

Russian statesmen have long held the view that Great Britain is an intruder in Asia, and that Russia itself has been singled out by Providence to become the predominant Power in that continent in the fulness of time. The recent successful attempts in this direction on the part of Russian statesmanship, both in the Near East and in the Far East of Asia, are well known to the world. Russia's gradual advance into and stealthy absorption of various districts in Central Asia during the last thirty years have continuously enlarged the frontiers of the Empire, and Russia's unchecked march towards Persia and South-Western Asia may be likened fitly to the imperceptible progress of a glacier. As the various schemes set on foot during the last sixty years for constructing a line of railway along the Valley of the Euphrates were not carried out, Russia seems to have entertained the idea that she could afford to wait, and she then set to work to develop Siberia, and to establish herself firmly on the shores of the Pacific Ocean. She now awakes to find that Germany, whose natural outlet for expansion is towards the south, is in a position to open up Mesopotamia. Nevertheless, all hope is not to be abandoned by Russia, for there will still remain Persia to be absorbed. The *Novoë Vremya* has lost no time in urging the Russian Government to bring great pressure to bear on Persia without delay, for the purpose of obtaining from the Shah the exclusive concession to construct railways in his country as a counter-move to German enterprise. But Russia has already obtained such a concession, which, although it has been renewed twice, has not been turned to account by her, and the Shah will be fully justified if he hesitates before he consents to hand over his country to a Power which is most palpably inspired by no desire to benefit and develop Persia, but simply and entirely by the desire to realise her long-cherished dream of obtaining an outlet on the Indian Ocean. The Russian military road opened last September between Resht and Teheran is clearly the thin edge of the wedge that is destined to rive Persia solely in the interests of Russian ambition. A body of Russian engineers is now on its way to Persia for the purpose of surveying a Russian line of railway from Teheran, either to Bandar Abbas, at the entrance to the Persian Gulf, or to Chouba, or to Gwatar, which are both situated on the southernmost coast line of Persia. It remains to be seen whether Persia can be coerced, or will even consent, to play into Russia's hands in this manner.

Russia is the persistent enemy of every form of commercial competition. It is, therefore, no matter for surprise that the projected German railway to Bagdad should have raised an immediate outcry in Russian commercial circles to the effect that the development of the production of cereals in the region so long famous as the "Granary of the Old World" will inevitably lower the price of grain, and gradually drive Russian corn out of the markets of South-Eastern Europe, while German manufactured goods will be thrown upon a market which Russia fondly regards as being exclusively reserved for her own productions.

Still, with all this candid expression of alarm on the part of Russia at the prospect of German commercial competition, there has sprung up quite recently a desire on the part of the more influential section of the Russian Press to regard Germany rather as an ally than as a prospective obstacle to the furtherance of Russia's plans against Great Britain. This sudden *volte-face* is strikingly significant in view of the fact that during the present year the Russian representative at the Sublime Porte left no stone unturned in his persistent efforts to thwart Germany's endeavour to obtain from the Sultan the concession for constructing the Bagdad Railway. To that end the aid of the French representative at Constantinople was invoked and made the most of. The failure of French railway enterprise in Asia Minor has been a severe disappointment to Russian statesmen, for the sturdy German common-sense will not allow itself to be beguiled by the specious blandishments of the calculating Russian. Germany now steps forth as an important factor to be reckoned with in the further development of the European Eastern Question, and Russia may well be pardoned for so promptly accepting the inevitable, and for somewhat prematurely heralding in the presence of the Teuton on the Persian Gulf the dawn of a day which, in the fond expectation of the Russian Press, shall witness eventually the overthrow of Great Britain's political and commercial supremacy in the Persian Gulf and on the Indian Ocean.

ELECTRIC LIGHTING COMPANIES AND CONSUMERS.

SINCE we dealt with the shortcomings of those who undertake to supply the public with electric light and do not, some correspondence has appeared in the *Times*, which serves admirably to set forth the truth of our statements. The Metropolitan Electric Supply Company endeavours to find an excuse for its failure to do the work it has promised to perform, in the assertion that Welsh coal of the best quality cannot be had because of the war, and that in consequence sufficient steam cannot be made to maintain the current. A "Coal Merchant," writing also to the *Times*, backs up this argument by asserting that Welsh coal of the best quality cannot be had for love or money. No more complete manifestation of ineptitude could be put forward. In the first place, if proper contracts had been made for the supply of the coal it would have been obtained, war or no war. The Government have not gone so far as to seize coal not for sale; and coal merchants and colliery proprietors of any position would not permit the demands of the Government to interfere with the rights of a public company. The fact that the necessary coal cannot be had is circumstantial evidence that no such contract was made. But all this is quite beside the mark. No prudent engineer, if he had a free hand, would put down boilers which would not make steam unless they were fired with some special kind of fuel. The quantity of the best Welsh coal used for making steam on land in stationary boilers is comparatively small. It is principally used for the Navy and for locomotive engines. We have no knowledge of the boilers at Willesden, but we have not the smallest doubt that, let

them be what they may, they can make steam with North-country coal. The letters of the secretary to the Metropolitan Company are simply admissions that the boiler power at the station is deficient. That is to say, sufficient plant has not been provided to satisfy the demands of customers as they ought to be satisfied. If, however, it is argued that there is plenty of boiler power if only the right kind of coal were available, the answer is that boilers of that construction are quite unfit for electric lighting. Welsh coal of the highest quality is very dear. This is, however, a matter which concerns the shareholders alone. Its supply is at the mercy of miners who have always been ready to strike, and who are now and have been for a long time past in a condition of unrest. How are the customers of the Metropolitan Supply Company likely to take a statement that they cannot have light because the colliers in a comparatively small district in South Wales have gone on strike? It is only necessary to state the matter in this way to see how incompetent the management appears to be. There is no way out of the dilemma created by the apologies of the company's secretary. Either the boilers are of wrong construction, or there are not enough of them. We believe that the last alternative represents the truth, but we believe it only because we cannot bring ourselves to imagine that the directors of a public lighting company would so arrange matters that, failing the supply of one special class of fuel, they would be helpless.

The question of boilers, we may add here, in general for electric lighting purposes, requires careful reconsideration. Experience has been obtained which may prove of very great value if acted upon. It is to the effect that sufficient boiler power has not been provided, save in very exceptional cases. Extravagant ideas have been formed by enthusiastic directors as to the small quantity of steam that would be needed by engines supposed to be superlatively excellent. It has been taken for granted that results obtained on a trial run could always be had. The circumstance that slide valves and piston rings wear, and break, and leak, has been overlooked. Nothing resembling sufficient allowance has been made for the cleaning and repair of boilers. It has been suggested that something like 90 per cent. of all the boiler power of a station would always be available, when 75 per cent. would have more nearly represented the truth. From first to last stations have been, as we have already explained, overloaded, and in this fact is to be found the source of most of the electric lighting companies' troubles. Some people learn from their own failures or those of others, but, on their own showing, the directors of the Metropolitan Company seem to have learned nothing. Their prayer for time until they can get the best Welsh coal would be ludicrous if it were not deplorable. We have already last week put the truth before our readers. It has just been re-stated in the pages of the *Times*:—"Obviously the company could supply us just as efficiently now as last winter without the Willesden machinery running at all. But it has in the meantime contracted to supply new customers before it had the means of supplying all. Finding itself unable to supply all, it has chosen to break its contracts with some of its old customers instead of its recent contracts, made prematurely, with new ones." The company has no answer to this statement. Its secretary would have been wise had he said nothing.

THE METAPHYSICS OF PHYSICS.

Two books of recent date, both of importance, enforce the lesson that try how we may to find a way of escape, metaphysical questions, problems, puzzles, will entangle the skein of consistent thought which the teacher of physics endeavours to wind. The first of these books is a "Treatise on Dynamics," by Professor Tait, published in 1895; the other is a "Text-book of Physics," by Professor Watson, of the Royal College of Science, London, just issued by Longmans, Green, and Co. We have no intention of reviewing these books here; we have for the moment only to deal with a very few statements which they contain.

There are two distinct points of view from which physics are regarded. The first is the superficial way, which takes it for granted that a sufficient meaning is attached to all the words and phrases used by men of science or found in text-books. Heat, matter, motion, time, are regarded as words which define themselves. For most if not for all practical purposes this is true. Engineers, electricians, chemists, all practical workers, get on very well without attempting, or finding it necessary to attempt, to go below the surface. The superficial is for their purpose, as for most of life's dealings, good enough. The second way of regarding physics is radically different. It stipulates for precision. Words must not be used unless their meaning is carefully defined. The text book becomes, so to speak, a legal document. This is no doubt the true scientific method; and it is with it that we are just now concerned. The moment we attempt to marshal our ideas we find how much they lack precision. Underneath the superficial methods of thought to which we have just referred is a profound abyss of metaphysics; and we need only descend a very small way into this to understand how little we know about anything; how much our so-called knowledge of facts is really but a knowledge of words, and how almost impossible it is to leave with advantage the purely practical for the tempting metaphysical. We sincerely believe that the great body of writers on physics dread the metaphysics of their subject, and that they are goaded into dealing with it mainly by the questions which are put to them by their more intellectual pupils, or by the honest conviction that the so-called practical is but one side of nature's story. There are, of course, exceptions; for to some minds the more profound metaphysics, of no matter what, are a source of never-ending delight. A comparison of the text-books of to-day with those of twenty years ago will bring out forcibly the nature of a change which has taken place in the methods of dealing with, we had almost said, an every-day subject. Formerly the writer had not the least hesitation about definitions; now he is most cautious. Then, if a contradiction appeared in his statements, so much the worse for the contradiction. Now, the tendency is to produce more or less elaborate disquisitions by way of definitions. Is the student better off than he was before?

It is time to give a few examples of the modern method. Take the first page of Professor Watson's big book on physics—a very excellent treatise indeed, we may add. We find in it the following passage:—"If we give the name *Thing* to that with the objective existence of which we are acquainted by our senses, then it follows that in the physical universe there are only two classes of things; to these the names *matter* and *energy* are given. Time and space, and many other quantities, such as number, velocity, position, temperature, &c., are not things. . . . The statement that energy has an objective existence is, however, one which is not so readily accepted; in fact, its acceptance by scientific men only dates back a comparatively short time. Experiments, have, however, shown that energy, like matter, is indestructible and uncreatable by man. The objective existence is, as Professor Tait has pointed out, virtually admitted in a curious way by its being advertised for sale, it being quite common in manufacturing centres to see the notice, "Steam Power to Let." Turning to page 89 of the same book, we find that energy is defined as capacity for doing work. Here we have an excellent illustration of the difficulty met with in defining the scientific meaning of the simple word Thing. The infantile delight with which proof is found that energy really is a "thing" in an advertisement that power can be hired is amusing, while in no way convincing. Energy has no existence apart from time. It cannot be sold in isolated lumps. Professor Tait, in his "Dynamics," is very impressive concerning the way in which time and space condition energy. How it comes that capacity to do a certain act or produce a certain result should be classed as an objective thing, while motion, without which energy certainly has no objective existence, is excluded, it is not easy to say. The question is further complicated by the splitting up of energy into two species, kinetic and potential. The latter, at all events, is in no way objective. Professor Watson seems to have forgotten the duality, or perhaps he accepts as sound the latest view that all energy is kinetic. But there is scarcely a term used in dynamics about the meaning of which it is not possible to wrangle. Pity it is that it should be necessary to weaken the foundations of mechanics by trying to find out of what they are composed.

Proceeding a little further, we come to the word Force. Time was when force was defined as that which produces or changes the motion of a body. It has now come to be admitted that this definition is scarcely in accord with facts. We take it for granted that Professor Watson will not call force an objective thing; but this is not the reason why the definition is defective. Try how we may to reconcile with Newton's third law the statement that force is the cause of motion, we fail. The old proposition has been pretty generally abandoned. Tait's teaching is being accepted, and we find now that action and reaction are defined almost as though they embodied a new discovery in the following words, which we quote from Professor Watson:—"When one portion of matter acts on another portion so as to influence its state, then the whole phenomenon of the mutual action of the two portions of matter is called, in general, a stress. . . . Action and Reaction are simply different aspects of a stress, as buying and selling are different aspects of one and the same transaction." The metaphysics of the phenomenon are too deep for Professor Watson, and a more lame illustration of what takes place than buying and selling could not be got. Further on we come to the old difficulty about the canal boat, the horse, and the rope. Professor Watson gets over it *en bloc* by ignoring it. The specific question is, that as the boat pulls the horse as much as the horse pulls the boat, why does the boat move? His reply is that the horse and the boat are virtually one, and that we must go to the horse's feet and the ground for the cause of motion. An old and time-worn explanation this. Surely an evasion of the metaphysics of the subject. There is no such phenomenon in nature, *pace* some text-books, as an unbalanced or partly balanced force. We cannot measure a force save by the resistance offered to the force. We can only measure one side of a stress. The truth is, that while a stress is a concomitant of change in the direction or amount of motion in a body, it is not the cause of the change. Professor Tait's metaphysics are far in advance of Professor Watson's. Tait takes in other elements, namely, time and space, and, passing over entirely the notion that force is the cause of motion, he shows that it is nothing more than an "expression for the space rate at which energy is transferred," or, in another form, that it is "the time rate at which momentum is generated in the falling stone." Here we have not the single idea of force, we have it mixed up with the ideas of space and of time, and we not unnaturally ask ourselves whether the force of which Professor Tait is speaking is precisely the same thing as that which the average thinker thinks of when he tries to lift a weight or pull a rope. If we push home an inquiry of this kind we shall soon see how easy it is to break adrift and get ourself lost in a wild sea of speculation. Perhaps after all the old dogmatic superficial methods of teaching physical facts, and leaving definitions alone, were the best. There is not infrequently a strict parallel between the philosopher, and the judge whose decisions were always right, and his reasons for giving them invariably wrong.

Many metaphysical problems in physics may be made to centre on the ether, which possesses apparently all possible qualities and qualifications negative and positive. It would appear to be at one and the same time something and nothing; neither matter nor force—and yet both. On what it is, turns in the main, it would seem, the explanation of what is energy. Each man who wants it idealises it for himself. On its existence hangs the whole theory of light, magnetism, and electricity—to say nothing of other matters. The phenomena of light have been more difficult to reconcile with any theory of the ether than have, perhaps, any other phenomena with which we are acquainted. When the corpuscular theory was rejected the wave theory was adopted, and for many years accepted in a more or less half-hearted way by those who really understood the subject, while it was gaily taught as a mathematical certainty in our schools and colleges. Now, however, a new undulatory theory is being developed, and with its development comes the difficulty of finding words to explain it. Once more we give a quotation from Professor Watson's book. It is possible that our readers will understand its meaning; we do not. Having shown that according to the old wave theory there must be longitudinal waves, he says:—"We have no evidence, however, of the existence of such longitudinal waves in the ether in the later form of the undulatory theory, called the electro-magnetic theory of light. The supposition is made that the vibrations consist not in the change of position in the ether particles, but in a periodic alteration in the electrical and magnetic condition of the ether during the passage of light." Dr. Lodge, we may incidentally remark, believes that the ether is continuous, and therefore there are no particles. Professor Watson, obviously in sore straits to find words which will convey his meaning, goes on to say that when he speaks of a particle he does not really mean a particle, but a condition. "We shall also sometimes talk of the displacement of an ether particle during the vibration, but this must be taken as a short and convenient method of stating the displacement of the electric and magnetic conditions of the ether at the point under consideration."

Illustrations of the variety of opinions might be multiplied. While some authorities tell us definitely what they think the ether is, others even doubt its very existence. Some time ago, a contemporary holding that we had written disrespectfully of the ether, appealed to Professor Fleming, of King's College, for assistance. In reply, Professor Fleming wrote a letter in which he kindly explained that the mistakes into which we had fallen were due to our acceptance of Dr. Oliver Lodge's theory of the ether as fairly representing scientific thought. He held that if we had but mastered Lord Kelvin's views, or taken into consideration Clerk Maxwell's theory, we could not have blundered. So far so well; but, unfortunately for our contemporary, Professor Fleming went on to express a doubt that there is an ether at all, which is certainly far more disrespectful than anything we have said. We commend his precise words to the consideration of our readers. Here they are. They are an eminently appropriate conclusion to this article:—"The attempt to go too fast in a detailed mechanical interpretation of physical effects leads to difficulties. It is no doubt natural, especially to the engineering mind, to desire a neat, simple, and easily understood theory of such an important material as the ether, if it exists at all, but it is well to bear in mind a remark Maxwell once made at the conclusion of a Cambridge lecture, to the effect that, 'even if we can imagine a mechanism capable of perfectly accounting for the processes we see in nature, it does not in the least degree follow that it is really done in that way.'"

A LESSON FROM THE TRUSTS.

THERE has for some little time past been sitting at Washington a Government Commission appointed to take evidence on the subject of American industries, and incidentally to ascertain the exact incidence on the manufacturing trade of the country of the numerous trusts formed during the last eighteen months. Practically everyone of any authority has been free to appear before the Commission, and, as may be inferred, the diversity of view in the statements made has been well on a par with the diversity of interests involved, especially in connection with the trusts. We need not concern ourselves with the bulk of the proceedings of this body to date, further than to remark that the consensus of opinion appears to be decidedly against the contention of the representatives of the trusts themselves that these combinations are beneficial in their operation, not only to the promoters, which has never been questioned, but also to the population at large—a fact which is not quite so self-evident. The evidence of two gentlemen, however, seems deserving of particular attention. The one is the managing director of the American Steel and Wire Company, and the other a tinplate maker of Pennsylvania. The first is favourable to the "combines"—the second is not; and by setting off the one against the other we may, perhaps, be enabled to arrive at a not overbiassed conclusion. But the evidence of these gentlemen is interesting primarily for what the newspaper reporter would call the "revelations" made by each one. Mr. Gates, the first of the two, went into details as to the efforts made by him on behalf of his company to consolidate all the wire-producing interests of America and Europe—in other words, virtually all the wire-producing interests of the world. Of this magnificent scheme we knew little until Mr. Gates condescended to enlighten us. Rumours of the intention we had heard, of course, just as we had been told of the design of the Standard Oil group of financiers to acquire control of the world's output of copper; and we had not regarded them seriously, because of a recognition of the immensity of the task involved and of the known repugnance of producers in Europe to the idea of placing themselves in the hands of a party of enterprising Yankees, and of playing second fiddle to them. But it seems that a very determined effort was made by the American Steel and Wire Company to effect the purpose which brought Mr. Gates to Europe. That company, when first formed, was a combination of about a dozen wire-making businesses in various parts of the United States; and it will be remembered—the fact was

chronicled in these columns at the time—that in January last it absorbed about a dozen more, and in this way secured to itself 95 per cent., or thereabouts, of all the works of this particular kind in America. What more natural than that the promoters, after this consummation, should have sought to spread their operations to Europe? Mr. Gates visited Great Britain, France, Germany, and Belgium, and other countries, and he is reported as having said this before the Commission:—"Germany he found to be the principal competitor, England's work in this respect not being sufficient to deserve serious consideration. In Germany the one source of fear in manufacturing centres was competition with the United States, and bounties and subsidies were given on every hand to hold up the manufacturing interests of that country." From his further evidence we gather that the German manufacturers at first proposed that, in case of an international consolidation, the United States should be content with 25 per cent. of the product. This Mr. Gates declined, and they had afterwards increased the allowance to 55 per cent., which was scarcely more satisfactory than the other to a man who, as he afterwards informed the Commission, thought that America should control 90 per cent. of the whole, or, at any rate, not far short of that proportion. Another rock upon which the negotiations struck was that of prices. The American gentleman "represented the possibility of increasing prices to the extent of about 10 dollars a ton in case of the proposed amalgamation," but the greedy Germans wanted about 20 dollars. Had they been at all conversant with the ways of the average American "combine," they might have taken the smaller figure, in the full assurance that, once the amalgamation was completed, it would have been doubled. In brief, the negotiations came to nothing, and though he does not expressly say so, there is no doubt that Mr. Gates found the "order" too large for execution. The jealousy of America on the part of the Germans would have been quite enough to kill any combination project advanced. From his contemptuous dismissal of the United Kingdom, we infer that Mr. Gates met with absolutely no encouragement here. The rest of that gentleman's evidence consisted of a repetition of the old contention that the rise in prices has been due to demand and supply, and that the advance in wire products had been proportionate to the increase in cost of raw material and wages. But we note that he qualified his assertions by adding "generally speaking"—a phrase exceedingly elastic in its nature.

After all that has been said about the philanthropic intention of the trust promoter—the repudiation of all desire to secure a monopoly, and the talk about economies of working and consequent reduction in cost to the consumer—it is interesting to turn to the evidence of the tin-plate maker referred to above. His company had been sold without his sanction by his partners, under the representations of the promoters that the consolidation was necessary to prevent competition, and the fear that if they did not go into the pool their business would be injured. This was not his view, and he was building works in the vicinity of the old shops. In re-establishing himself he had been greatly hampered in securing machinery, the American company having control of the makers of tin-plate machinery, as well as of the manufacture of plate itself. In proof of this statement, he said that a manufacturing company which had entered into an agreement with him to supply him for five years had already refused to fill an order after an official of the trust had become a large owner of the stock of that company. The restriction, he said, also extended to the independent manufacturers of sheet iron, the American company refusing to sell to them except on the stipulation that they should not sell their product to the makers of tin-plate. Furthermore, the combination refused to supply jobbers and others with their especial brands to the trust. There was a similar restriction on black plate, and half the "dippers" in the country had been forced out of business. He thought the managers of some of the plants in the trust were growing restless under these restrictions, as they were not running nearly so steadily as before the combination was effected. Last year the company of which Mr. Griffith was a partner made a net profit of 20 per cent. with the price of tin-plate 2.60 dols. per box of 100 lb., the lowest figure ever touched in the country. Since the formation of the trust the quotation has advanced, as our readers know, to about 4.65 dols. per box. In the opinion of this witness, the rise was "out of proportion to the advance in wages and raw materials." He made a calculation to show that 3.84 dols. would be a profitable price under present conditions. However, he said that "notwithstanding this advance in prices, he had reason to believe some of the members of the combination were greatly disappointed in the results." He also understood that the employés in the trust mills were becoming apprehensive, which he thought was illustrated by the fact that of the 800 rollers employed by the combination no less than 150 had made application to him for places in his establishment." Mr. Griffith said that while the American company was capitalised for 50,000,000 dols., the plants comprising the combination could have been bought at the time the deal was effected for 12,000,000 dols. He therefore considered the company over-capitalised—a rather obvious conclusion. He had understood that the promoters of the combination had received 10,000,000 dols. in common stock for their services. This may or may not be literally accurate, but we are justified in assuming that these individuals arranged for a handsome honorarium, and that they are depending upon the maintenance of very high prices to enable them to pay fair dividends on a capital that is ludicrously high. Exaggerated capitalisation is a fault which the tin-plate company shares with every one of the other trusts formed on the wave of this recent industrial boom, and it is this which must militate in the future, whatever the abstract aspirations of the organisers may be, against relief to the consumer when the cost of production becomes lower by the drop in wages and raw materials. Personally, we believe that the trusts, one and all, would take full advantage of their opportunities in any circumstances. The tariff is favourable at least to the partial exclusion of foreign commodities, and if a combine is powerful enough to impose its own prices, it may be counted upon as a business organisation to do so. But even though it might desire to play a fairly reasonable game it cannot afford to do so in good times and bad alike, simply and solely because of the necessity of paying dividends on capital of which less than one-half represents *bonâ fide* subscriptions for the purposes and extensions of business.

LOCOMOTIVE COAL.

ONCE again coalowners and railway companies' representatives are engaged in trying to fix the prices for supplies of steam coal for the ensuing year. The task is seldom a pleasant one, for whilst the colliery owners are bound to take into consideration the ever-increasing wage question, railway directors are obliged to do what they can to keep so material an item as their coal bill as low as possible. Generally speaking, railway companies' directors are almost powerless to increase rates as they would wish to meet extra expenditure. When it is stated that in 1887-88, prices of locomotive coal ruled at 6s. to 6s. 6d. per ton, and advanced to 8s. to 8s. 6d. per ton in 1899, reaching 10s. 6d., and even 11s. per ton in 1890, some idea of the importance of placing contracts may be imagined. Many lively encounters might be mentioned, particularly in connection with large companies, some of which consume over 50,000 tons of coal per month. Prior to the commencement of the half-year which is now drawing to a close, the South Yorkshire coalowners sent in tenders at the rate of 11s. per ton. Several large consumers and railway companies rebelled, and amended tenders were submitted at 10s. 6d. per ton. The Midland Railway Company offered 9s. 6d. per ton, which was rejected, and several large Yorkshire coalowners have been without their usual contracts. For next year's supplies South Yorkshire coalowners sent in tenders at the rate of 10s. 6d. for the first half of the year, or 11s. per ton for the whole year. Negotiations have been quietly conducted, and it is now stated that the North-Eastern Railway Company has closed with one or two firms at the rate of 10s. 6d. for the first half of the year. So far as can be gathered, the agreement will extend to other collieries. What course the Midland will take is at present not known; but in the face of the fact that steam coal is now in better request than it was six weeks ago, and that prices in the open market range from 10s. to 10s. 6d. per ton, it is more than probable that other companies will follow the example set, which is an increase of fully 6d. per ton on the expensive contracts.

THE LONDON COUNTY COUNCIL AND THE PORT OF LONDON.

THE London County Council have under consideration the subject of improving and cheapening the dock accommodation of the Port of London. An investigation has been made of the matter in all its branches, and the information obtained will eventually be put into the form of returns. Some of these are not yet available, so that at present we can only see the directions in which the investigations have been made. The first portion of the inquiry, however, was devoted to the extent, limits, and general character of the Port of London. The information obtained relates to the geographical extent of the jurisdiction of the different authorities for various purposes, particulars of the different navigating channels, the tidal effects, the pools and reaches and the entrance channels below and above London Bridge, the several canals, navigations, rivers, brooks, and creeks connected with the Thames, the towing paths and embankments, the principal impediments to navigation, consisting of the shoals, bridges, channels, islands, aits, locks, and weirs, and the condition of the estuary and the entrance channel. The return also gives an analysis of the extent of the dock accommodation afforded by the several dock companies, including the railway communication to the docks, and the barges and lighters used in connection with them, and other particulars concerning legal quays, sufferance wharves, up-town warehouses, &c. Then the return goes on to deal with the industries of the port, including the markets and shipbuilding, the vessels belonging to and trading with the port, the commerce of the port for certain years, the lights, buoys, and beacons within the port and the pilotage regulations. The return in connection with the second portion of the inquiry is nearly completed. It deals with the authorities having jurisdiction within the Port of London, and their rights as they affect the river, port, navigation, shipping, and commerce. It will show where the jurisdictions are conflicting. The object of the Rivers Committee, when they get the return, will be to see how far this confliction is injurious to the best interests of the port, and how it could be remedied. This return will show the modes of government in the different ports of the United Kingdom, which have been compiled to "see how far the London system is behind or in advance of that which obtains elsewhere." The third part of the inquiry deals with the dock authorities of the port. The return, which is not yet completed, will contain an analysis of the capital expenditure of the several companies, and their revenue account for a series of years, together with a list of the tolls levied upon shipping. This part the Rivers Committee consider very important, because "it has to deal with the policy and results of the taxation of shipping for port purposes, and, when finished (the return) will show the comparative rates of charges and their effects upon shipping among the principal ports of Great Britain and the Continent."

The conclusions of the Rivers Committee will not be presented till after the whole of these returns have been made. Meanwhile, we observe that the Committee have had their attention drawn to the notice given by the London and St. Katherine Dock Company and West India Dock Company that it is their intention to apply for parliamentary powers to amalgamate, to dissolve the London and India Docks Joint Committee, and to transfer the powers of this Committee to the amalgamated companies. These circumstances, and others which have come to their notice, seem to have considerably affected the Committee, though why it affects them it is hard to see. The position they take up is apparently that the County Council, if they could obtain the management of the shipping and Port of London, would conduct matters far better than they are being conducted at present. This is, at all events, open to doubt. The Committee, however, recommend that these Bills should be opposed. The question uppermost in one's mind in hearing all this is, "How does the County Council come into the matter at all?" It is hard indeed to find what status they could possibly have. Is it their desire, we wonder, to purchase the whole of the docks, &c., connected with the Thames, and start, with the money of the ratepayers of the County of London, a gigantic trading concern, with the great likelihood that they would make an equally gigantic failure of it? This can be the only reasonable solution to the matter. For what other purpose are these returns intended—especially that in connection with capital expenditure? Whether or not these two companies should combine is not the question we are dealing with at the moment. It may or may not be right; but what we fail to see is how the London County Council imagine it their business to interfere. Their attempts, so far, at buying up companies have not met with any very great success. It remains to be seen how they will fare in this instance. If this is in reality their design, the argument they adduce for their action seems to us to condemn them on the face of it. The Rivers Committee, in their report, say, "We are of opinion that the question of the amalgamation of the dock companies is one which seriously affects the well-being of the whole of London . . . ." And yet there seems every likelihood that the Council have an idea that they will bring all the docks into one huge combine under their own rule. We cannot imagine for one moment that they will succeed.

AMERICAN LOCOMOTIVES FOR WELSH RAILWAYS.

IN our last impression we published engravings and a description of heavy tank locomotives built in the United States for the Barry and the Port Talbot Railways. The information was supplied to us directly from the United States by our own American representative. We have received from Thos. W. Ford and Co., of Palace-chambers, Westminster, and also from Evans, O'Donnell, and Co., Limited, of the same place, some corrections, which we give as requested.—The order that was placed by the Barry Railway Company was for five engines, and not for ten, as stated in our article; and an order for two was placed by the Port Talbot Railway Company. It is stated in our article that the United States metallic packing is used for the piston-rods and valve stems. This statement is right so far as the Barry Railway is concerned, but in the case of the Port Talbot engines, the United Kingdom metallic packing, as made by the Leeds Forge Company, is employed. It is satisfactory to know that materials, according to the following lists, were sent out from England. For the Port Talbot engines:—Rubber draw-bar springs, Geo. Spencer, Moulton, and Co., Limited; vacuum brakes, Vacuum Brake Company; injectors, Patent Exhaust Steam Injector Co.; cylinder lubricators, Vacuum Oil Company; buffers, Ibbotson Bros. and Co., Limited; metallic packing, United Kingdom Metallic Packing Co., Limited. For the Barry engines:—Vacuum brakes, Vacuum Brake Company; rubber draw-bar springs, Geo. Spencer, Moulton, and Co., Limited; injectors, Patent Exhaust Steam Injector Co.; cylinder lubricators, Vacuum Oil Company; Jenkins' patent blast pipes, Edmunds and Radley; buffers, Ibbotson Bros. and Co., Limited. We are further requested to state that Evans, O'Donnell, and Co., Limited, have no connection with The Cooke Locomotive Company. Thomas Ford and Co. are the European agents for the American company, and the orders for the engines were placed by Thomas Ford and Co. We may add that the locomotive engineer of the Barry Railway, Mr. Hosgood, went to the United States specially, and saw to the construction of these locomotives, and also made sure that the English practice in every possible way should be adapted to what is termed the American design. The locomotive as designed appears to be a happy combination as to what is good in the American locomotive added to what is good in the English, and we are told that the men working these engines like them better than the ordinary English type. The grades of the Barry Railway are in certain parts very difficult, and the Cooke locomotives are hauling between 500 and 600 tons over severe grades, the coal consumption being given as about 41 lb. per mile.

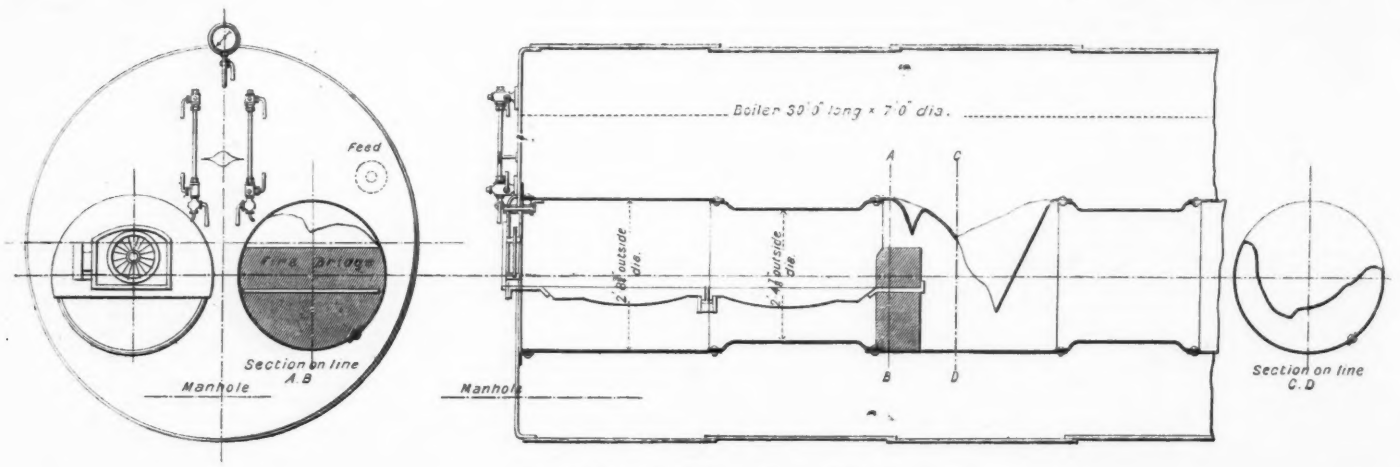
DEATH OF MR. ROBERTSON.—Much regret will be felt in the engineering world at the death of Mr. James Robertson, which took place at his residence, Holleth, Westcliffe-road, Birkdale, on Sunday, the 3rd inst. Deceased, who was seventy-eight years of age, was one of the most prolific inventors of the day. He was born at Farnell, in Forfarshire, and received his training at Randolph, Elder, and Company's works, Glasgow. He subsequently became a partner in the firm of the Patent Friction Gearing Company, Glasgow, and after forty years' residence in Scotland, crossed the border, and became associated with many important engineering firms in Birmingham, St. Helens, and Manchester. He was also at one time manager of the Camlachie Foundry, Glasgow. Mainly owing to his inventive faculties, many important improvements were effected in hydraulic machinery for the manufacture of tubes of all metals, and there are few concerns in the country which do not now avail themselves of Mr. Robertson's inventions. One of his last ventures was to establish the St. Helens Tube and Metal Company, which was subsequently disposed of to a Birmingham company known as Tubes, Limited. Mr. Robertson has lived quietly at Birkdale for the last two years, and his death, which was due to apoplexy, was somewhat unexpected.

DEATH OF MR. PEEBLES.—The death has occurred in Edinburgh, in his 73rd year, of Mr. David Bruce Peebles, who was well known in engineering, gas, and scientific circles. Mr. Peebles's needle burner and governors alone have made his name a household word. Born at Dundee in 1826, he remained in that town till after his apprenticeship in the works of Messrs. Umpherston and Kerr. He then entered the Great Western Railway Locomotive Works at Swindon, where he was engaged for several years, afterwards connecting himself with the locomotive works at Amiens. Leaving there, he spent some time in Leeds with Messrs. John Fairbairn and Co., after which he returned to Edinburgh and joined the firm of Messrs. Fullerton and Co., gas meter manufacturers. In 1865 he left that firm and started business on his own account in the Fountainbridge district of the Scottish capital. These works proving too small for his rapidly extending business, Mr. Peebles acquired extensive ground in the Bonnington district, on which he erected large new works. It was here that he brought out most of his inventions, which have gained for him in gas circles a wide reputation. In 1897, recognising the affinity of the two great illuminants—gas and electricity—Mr. Peebles added to his gas business a very extensive electrical department, which is now one of the largest in Scotland. He was an active thinker, as well as worker, and contributed many papers to the Gas Institute, to the Royal Scottish Society of Arts, of which he was a past president, and to the Royal Society of Edinburgh, of which he was a Fellow.

THE SHEFFIELD BOILER EXPLOSION.

THE Board of Trade inquiry into the fatal boiler explosion which occurred at the works of Southern and Richardson, Sheffield, on November 1st, was concluded on December 6th. The boiler was made by Hawksley, Wild, and Co., in 1875. A drawing of it, showing the extent of the damage, has been sent to us by the makers, and two views are reproduced herewith. It will be seen that the flue is stiffened by a system of flanging, which from the manner in which the rupture has been arrested would appear to be very efficient. The boiler was made entirely of iron; it was of the Lancashire type, 30ft. long by 7ft. in diameter. The shell plates were $\frac{7}{16}$in. thick, originally there were four cross tubes in each flue, but two were ultimately taken out of each, and the holes plated over. The patches are not shown in the drawing. The safety valve was loaded to about 66 lb.; and two automatic gauge glasses were fitted, the centre of the bottom cock of each gauge being $1\frac{3}{4}$in. above the crown of the furnace, and the bottom of the glass $2\frac{1}{4}$in. higher, so that when water was just showing in the glass there would be 4in. over the highest point of the furnace crown. The pointer between the glasses was set to 4in. in the glass. The boiler was tested to 120 lb. hydraulically, and was intended to be worked at 70 lb. It had been invariably looked after by the makers, and since 1885 had been insured in the Engine, Boiler, and Employers' Liability Insurance Company. Once a year this company sent an inspector to make a thorough examination, and three or four times a year it was examined at work. The last inspection was in December, 1898, and shortly afterwards it was scaled, and the use of a boiler composition which it was believed was causing grease in the boiler was discontinued. About three weeks before the explosion a water gauge broke, and when a new glass was fitted it was found to leak, and was shut off, as some washers that were required, although on the premises, were not forthcoming. On October 29th, a Sunday, two workmen finding the boiler had filled up, opened the drain cocks of the gauges and allowed the water to run out for about two hours. Next day another man, finding the glass still full, opened the cocks until water showed. Pressure was raised to 65 lb., and one gauge glass was kept working, and being blown through appeared to be in good order. About 8.20 on November 1st the steam pressure was 60 lb., and water was in the glass a little below the working level. About 9.30 a small stream of water was seen coming from the left-hand furnace, but it was considered of no immediate consequence. The feed pumps had been partly shut down, as the fireman thought they were working too "strong." Soon after the leak was discovered the explosion occurred. The crown of the third ring in the right-hand flue collapsed and ruptured—an opening about 2ft. $2\frac{1}{2}$in. by 2ft. 7in. being made. The fire bars, bridge, fuel, and furnace front were blown out, and the brickwork flues were seriously damaged. Seven persons were killed and ten injured. After the accident the boiler was examined by Mr. Hawksley, Mr. Longridge, and Mr. Lawton, of the Insurance Company; Mr. Seaton, of the Board of Trade; and by Mr. Hiller. All were of the opinion that the explosion was caused by overheating due to low water. With the exception of the damaged plate, the boiler was in good condition.

After hearing a number of witnesses, the Court found the accident to be directly attributable to a defective gauge. One gauge glass was out of action and the top passage of the other was stopped with deposit, and the skilled witnesses were of opinion that under such conditions the vagaries of the water in a glass cannot be accounted for. The Court was of opinion that a fusible plug should have been fitted, and that the second gauge glass should not have been left out of action, but they did not pronounce anyone to blame, and made no order as to costs.



EXPLODED LANCASHIRE BOILER, SHEFFIELD

DOCKYARD NOTES.

IT is now reported, as we half prophesied a few weeks ago, that the projected 15,000-ton French battleships will not be built. If they are abandoned, it will signify that the French Administration have no faith in that Franco-Russo-German alliance which is to sweep the British fleet from the seas. Possibly they are right enough, because no coalition yet succeeded in doing anything on a par with its numbers. At the same time the adoption of piracy or a *guerre de course*—to give it its technical name—is likely to be a very poor substitute.

THE lecture on "Naval War Game," by Mr. Fred. T. Jane, at the United Service Institution last week, touched on nothing particularly new to those who have followed THE ENGINEER'S reports of the game, unless we except certain remarks to the effect that the strategical game usually shows the "fleet in being" theory to be illusionary. Some of the subsequent actions were of a certain general interest. For instance, the Shikishima and Magnificent, allowed a maximum of 15 knots, easily, and without much loss to themselves, defeated the Peresivet, Sardegna, and Centurion, all allowed 18 knots. It was the old story, that many weak are no match for a few strong. The rival admirals were Lieut.-Commander Takarabe, I.J.N., of the destroyer Niji, now building at Yarrow's, and Lieutenant Hearne, R.G.A.

OF the minor actions one, in which Mr. H. O. Arnold-Forster, M.P., participated, between the Powerful and Asama, was the most interesting. The former vessel came out an unexpectedly easy victor, mostly by virtue of her armour-piercing 9·2in. guns and her enormous bulk. Her size renders her an easy target, but at the same time an amount of shell fire which would blow a small ship to pieces is only enough to wreck partially such a huge hull as the Powerful's. The action was finally decided by torpedoes and manœuvres to use them; but previously to that, gun fire had well-nigh settled things in the big ship's favour, notwithstanding that she received by far the larger proportion of hits.

THE big modern guns, to which we recently referred as about to be placed in the French Dévastation, have been put in the battery of the Courbet instead, as the former has to be re-boilered, and so will be out of service for some time. It appears that the sterns of both ships have been or will be cut away, and the new 9·6in. pieces aft are no longer covered in by a deck, as the old guns there used to be. Some superstructure has also been removed from about the funnels in each ship, so as to minimise the chances of the 9·6in. guns amidships being blocked by wreckage in action. Altogether the French seem to be "transforming" with a good deal of method.

A CURIOUS sign of the times is a growing feeling in the service that the 110-ton gun is a piece *par excellence*. It is slight and very gradual as yet, still there is a deal more respect for the 110-ton than there was five years ago. The root of the feeling lies in the fact that a single hit from a 16·25in. is as much as most ships afloat could want to settle them, whereas two or three 12in. projectiles might be survived. The great objection to the 110-ton gun was its slow rate of fire: still if it can be relied on to hit and settle the target in the hitting, its work is done in one go.

So far as we are aware, the 110-ton gun was mounted in our Navy in deference to the clamours of certain "naval experts," while later on it was abandoned also in deference to the clamours of "naval experts," in some cases the same who had shouted for it. The naval officer, who did not feel qualified to give a hasty opinion on such a technical matter, seems to have been put to play second fiddle all through. There is no getting away from the fact that a shell which weighs a ton must do harm wherever it hits, and its damge, both moral and physical, is likely to be far greater than that of two or possibly three shells of half the weight hitting at different times. We wish to emphasise this point, because at the present day there is a tendency to reckon up guns by their energy alone, and some of the latest 12in. pieces are not far behind the old 16·25in. in energy. But energy is merely a matter of *penetration* with shot, and has nothing to do with shell fire. A 110-ton shell landing in, say, the main deck of the Majestic amidships, or under the many turrets of the Kaiser Friedrich der Dritte, would probably put all the casemates or turrets out of action without occasion to penetrate anything. And even supposing it to be burst outside by the 6in. armour of a ship like the Mikase or the Belgrano, it is very doubtful whether the subsequent shooting of guns on that side would be possible. The blast of such a shell would be enormous. All this applies, of course, in lesser degree to big guns of lesser calibre, but to nothing like the same extent.

THE Glory has arrived at Portsmouth to complete for sea. The Canopus, of the same class, will relieve the Anson, and not the Hood, as was projected a little while ago.

THE increase of the German navy is again to the front this week; but there is no particular change in the situation, nor has the matter as yet the importance that has been assigned to it in many newspapers.

IT is becoming gradually known that the French Minister of Marine, M. de Lanessan, returned from his recent visit of inspection of the naval stations on the northern and southern coasts of France with a very unsatisfactory opinion of their fitness. He has been obliged to put on record the fact that these harbours do not possess anything like the requisite number of dry docks for accommodating the modern colossal ironclads, and that there is also a great lack of coaling barges, tugboats, and the usual and necessary adjuncts of naval stations, which are requisite for quickly fitting out in every respect a squadron called together hastily. These shortcomings must have all the more depressing effect upon Frenchmen concerned with maintaining the naval strength and coast defence of their country, seeing that competent experts have already frequently shown that in the naval battles of the future even the victorious squadrons will have to send a great part of the fleet to various points for the purpose of being fitted out afresh for warfare. The cause of this undesirable state of matters is to be sought in the fact that the previous Ministers of Marine have been almost entirely concerned with obtaining credit votes for building new ships, while in so doing they have neglected completely the absolutely necessary requirements of the navy. Moreover, instead of increasing proportionately the general vote for the expenses of the growing navy, this vote has been allowed steadily to grow smaller. For example, the vote of credit for dry docks and repairing docks was 9,300,000 francs in 1885, and this estimate had fallen to 4,700,000 francs in 1896. It is rumoured that special attention will soon be paid to the naval harbours on the north-eastern coast and also on the Mediterranean.

THE COUNTY COUNCIL'S BILLS IN PARLIAMENT.

THE London County Council intends to have no less than ten Bills before Parliament this year. Two of these we have already remarked upon. They are the London Water (Purchase) Bill and the London Water (Welsh Supply) Bill. The former is practically the same as last year's Bill; the latter has been prepared pursuant to a resolution of the Council passed on November 7th last. With several minor alterations, the Bill practically consists of an amalgamation of the two Bills of last session. The estimate in the [illegible], which has been inserted on the recommendation of the Water Committee, amounts to £18,100,000. The amount still continues to grow. Last year the two Bills together only required £17,000,000. The engineer and valuer, however, put down the increase to the enhancement in the price of all kinds of materials and labour during the last eighteen months. Then the Council have got a General Powers Bill, which proposes the purchase of land for various purposes, &c. None of the provisions of this Bill, so far as we know, have any engineering interest, saving, perhaps, the question of giving powers to the Vestry of Battersea to utilise certain lands in the parish, which they already own, as a site for an electricity generating station. There is, of course, an "Improvements" Bill, one of the improvements being the extension of the Thames Embankment beyond Westminster Bridge. This Bill is to include a proviso to make the carrying out of the improvement, subject to a contribution of £100,000 by the "city or borough" of Westminster. There are two Bills in connection with the Metropolitan Tramways. The first of these deals with the extension and doubling of various tramways, and with the use of electrical traction on the lines from Westminster Bridge to Tooting, from Blackfriars Bridge to Kennington, and from Camberwell to Vauxhall. There is also a proposal to construct an electric generating station in Camberwell for working the tram lines. It is further proposed to extend the cable tramway along the Streatham High-road. In the second Tramway Bill power is sought to enable electrical traction to be used on all or any of the tramways acquired by the Council. The Bill also seeks to repeal the proviso in Section 24 of the North Metropolitan Tramways Act, 1897, which prohibits the use of electrical traction on the part of the North Metropolitan system which is in the County of London. Another Bill has been prepared with the object of giving effect to the Council's resolution to construct a tunnel to connect Rotherhithe and Shadwell; and, lastly, there is to be a Bill with the object of legalising tests made with a portable photometer of the gas of the Commercial Gas Company, the Gaslight and Coal Company, and the South Metropolitan Gas Company at other than the prescribed testing places. This Bill also seeks to regulate the charges made for gas supplied through automatic or slot meters.

AT a meeting of the Royal Irish Academy held in Dublin lately, Mr. Trouton showed an apparatus with which he had determined the heat required to evaporate steam from saturated salt solutions. The plan adopted consisted of an inner vessel completely surrounded by a larger one. The same solution is placed in both. The outer one is kept boiling by the application of external heat; the inner by an electric heater. The steam from the inner vessel is collected and weighed. In this way by knowing the heat supplied electrically the latent heat is found. The connection was also considered between the latent heat of evaporation from salt solutions and the cooling which accompanies the solution of the salt in water.

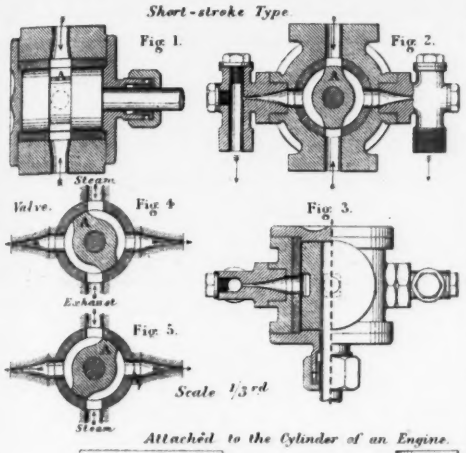
A CONTINUOUS MEAN-PRESSURE INDICATOR FOR STEAM ENGINES.*

By Professor WILLIAM RIPPER, Member, of Sheffield.

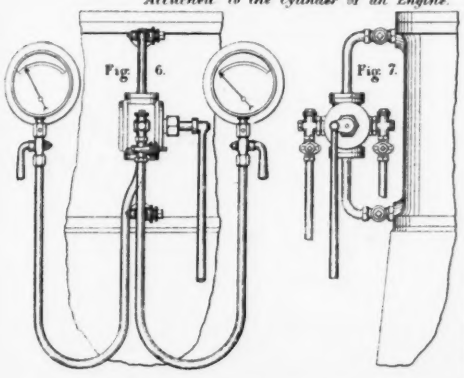
THE instrument described in the present paper was devised in the first instance for the purpose of measuring the mean effective pressure on the piston of engines running at high rotational speeds. For this purpose an arrangement was adopted to separate the driving or impulse pressures from the resistance or back pressures, and to divert these two separate effects into two separate pressure gauges, so that one gauge might give a continuous reading of the mean effect of the driving pressures only; and the other the mean effect of the back pressures only; the difference between the two gauge readings being the net mean effect. It was afterwards found possible to use the same instrument for engines running at any speed, high or low.

Description of instrument: short stroke type.—In the "Proceedings" of this Institution—1897, page 347—in connection with the discussion on Mr. Morcom's paper on "High-speed Engines," a description of the earliest type of this instrument was given, but since that date it has been somewhat modified, valves with either an oscillating or rotating motion having been substituted for a

Short-stroke Type.



Attached to the Cylinder of an Engine.



reciprocating motion of the spindle of the valve. Figs. 1, 2, and 3, illustrate the simplest type of the instrument. Figs. 6 and 7 show the same instrument attached to the cylinder of an engine. Fig. 2 shows the valve A in mid-position. The piston of the engine is then supposed to be at the top or bottom of its stroke. Fig. 4 shows the position of the valve, when the engine piston is at or about mid-position, and passing from the top to the bottom of the stroke, the steam from the top side of the piston passing into the driving pressure gauge, and the steam from the bottom side of the piston passing to the exhaust gauge. Fig. 5 shows the valve reversed, when the piston is travelling in the opposite direction. The driving steam again passes to the driving pressure gauge, and the exhaust steam to the exhaust pressure gauge, as before. The valve has no lap on either the steam or exhaust edges, and the respective ports are open to both gauges for the full length of the stroke. The valve is moving at its maximum speed at the points of opening and closing—that is, at the beginning and end of the engine stroke.

Long-stroke type.—In order to prevent loss of pressure through excessive length of the pipes which attach the instrument to the cylinder in long-stroke engines, separate valve boxes C and D, Figs. 8 and 9, are substituted for the single instrument, Figs. 1, 2, and 3. These valve boxes are placed as near as possible to each end of the cylinder, so that they may take the steam at once, without loss of pressure due to passing through pipes. The valve boxes are connected by pipes E and F, as shown, and the valves are so constructed as to turn the driving steam into one gauge G, and the back pressure into the other gauge H. The arrangement of the valves A and B is shown in the sectional view, Fig. 13. The engine piston is supposed to be at the top of the stroke. The valves A and B are moving in the direction of the arrows. The top valve is opening communication between the top of the piston and the driving pressure gauge, through the centre of the valve, and down the pipe E to the gauge G, Fig. 9; while at the same

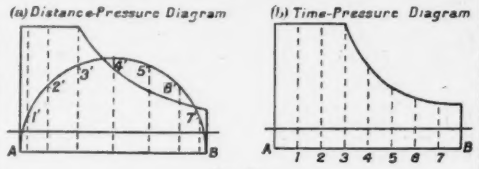


Fig. 25

moment the lower valve B has closed the steam communication between the lower end of the cylinder and the driving pressure gauge. At the same time the top valve is just closing, while the bottom valve is just opening communication with the exhaust side of the piston and the exhaust pressure gauge H. There is a partition in the valve separating the steam and exhaust sides of the valve.

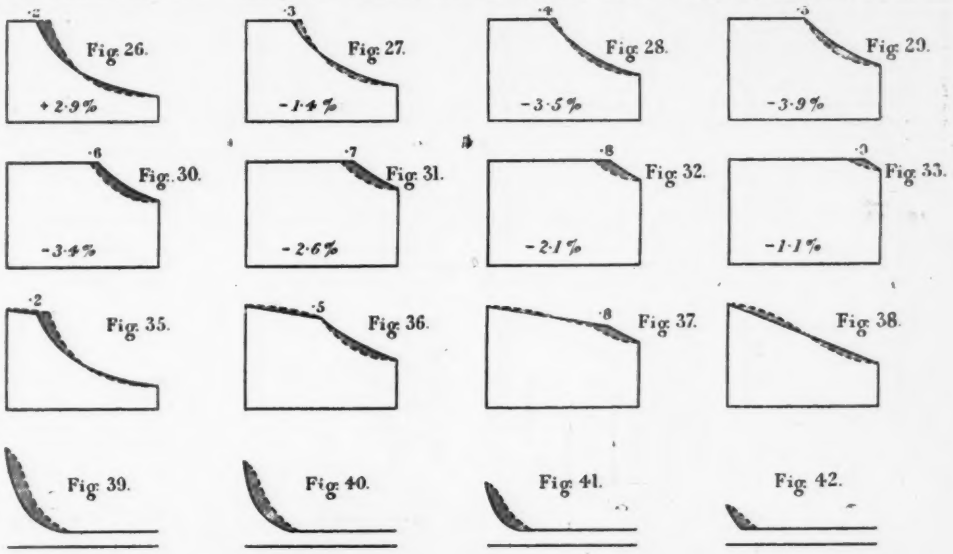
Fig. 14 shows an isometric view of the valves with the ports cut therein, and Fig. 15 shows that, when the faces of both valves are moving together in the direction of the arrows, the steam port of the valve A is opening to steam, while the steam port of the valve B is closing; also that the exhaust port of valve A is closing while the exhaust port of valve B is opening. The valves oscillate about their axes, and are driven by an excentric fixed on a countershaft, the countershaft itself being driven by a chain gear from the main engine shaft. Figs. 10, 11, and 12, show the arrangement of the instrument with a rotating valve for high speeds. With this instrument no excentric is required, the valve being driven by a chain wheel. The valve is hollow, and has two openings or ports which are on opposite sides and at opposite ends of the valve. The ports are respectively open during a half revolution to steam and during the other half revolution to exhaust. The steam is admitted to the gauge by entering the port at one end of the valve, passing through the centre of the valve, and entering the gauge pipe through the port at the other side and end of the valve. Figs. 17, 18, and 19, show the attachment of the long-stroke type to a horizontal cylinder.

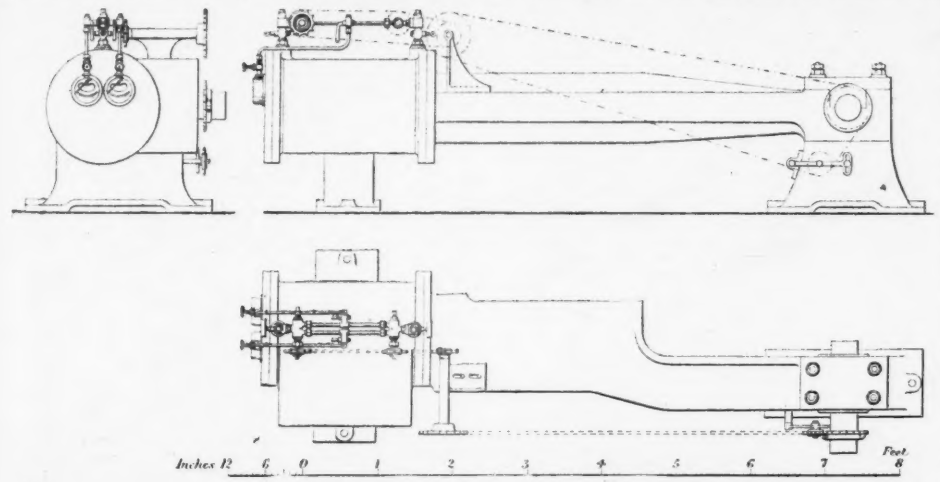
Time-pressure diagrams.—The first point to be observed is that the mean pressure obtained by this instrument is the mean pressure on a time base, and not the mean pressure on a distance base, as is given by the ordinary indicator diagram. If the piston of an engine moved at a uniform speed throughout the piston stroke, then the mean pressure on a time base would be the same as the mean pressure on a distance base; but since the speed of the piston is not uniform, the mean pressure per stroke on a distance base, and the mean pressure per stroke on a time base are not necessarily the same. The two kinds of diagrams are illustrated by the two methods of indicating shown in Fig. 16, where the indicator A is one of the ordinary type, whose drum is connected by a string to a moving part of the engine, giving it a motion to and fro, which is an exact copy to a reduced scale of the motion of the piston; and the diagram thus obtained is a pressure diagram on a distance base. Indicator B, on the other hand, differs from indicator A in having its drum connected to the engine by an endless cord, by means of which the drum is made to rotate uniformly and independently of the irregular motion of the piston. The diagram thus drawn on the uniformly rotating drum is a pressure diagram on a time base, because it gives the pressure during successive intervals of time, without regard to the space moved through by the piston in those intervals. But since work is measured by pressure × distance only, it is important, if the mean time pressure reading given by the gauges is to be of practical value, that it should be very nearly the same as the mean distance pressure, or otherwise that there should be a definite and known ratio between them, which may be used for converting the one into the other. In practice the actual difference is small, as will be shown below; but whatever the difference may be, provided the ratio between the two kinds of mean pressure is definitely known, it is easy to convert the one into the other directly by the use of a factor expressing the known ratio.

A difficulty here suggests itself that the conditions may be very variable in the same engine, and that different points of cut-off and compression would require different factors; but it is possible in practice to use an average factor, which may be applied through all ranges of power, in the same engine, to convert the mean time pressure into the mean distance pressure within very narrow limits of error. This may also be done without any calculation by an adjustment of the scale of the pressure gauge, as shown in Fig. 20. By the arrangement shown in Fig. 16, the diagram drawn on the drum of indicator B is shown in Fig. 22, and includes the forward pressure and the back pressure in one continuous line. If an ordinary indicator be attached to the mean pressure instrument in the manner shown in Fig. 21, then it is possible by coupling the indicator to the driving pressure nozzle to obtain, on one card, the forward or driving pressure lines taken together on one continuous roll, Fig. 23, or, again, by coupling the indicator to the back-pressure nozzle it is possible to obtain the backward or resisting pressure lines taken together on another continuous roll, Fig. 24. If a dotted line be drawn through the mean height of the variable pressure line, as in Figs. 23 and 24, this dotted line will represent the mean effect of the series of variable pressures, Fig. 23 for the driving strokes, and Fig. 24 for the back-pressure strokes. This mean effect is the reading given by the pressure gauges, which are respectively attached to the driving and back-pressure sides of the instrument. The movement of the pointers of the gauges is reduced to a minimum by throttling. The higher the speed of the engine, the more steady is the movement of the finger, other things being equal.

Relation between time-pressure and distance-pressure diagrams.—The method of converting a distance-pressure diagram *a*, such as is taken with an ordinary indicator, into a time-pressure diagram *b* may here be explained. A semicircle is described on the base A B of the distance-pressure diagram, Fig. 25 *a*, and the semi-circumference is divided into any number of equal parts, 1', 2', 3', &c.

Theoretical Diagrams showing the relation between Time-Pressure and Distance-Pressure.





INDICATOR FITTED TO HORIZONTAL ENGINE

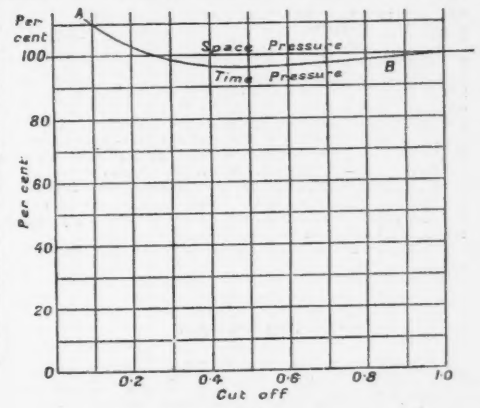


Fig. 34

Also the base A B, for the time-pressure diagram *b*, is divided into the same number of equal parts. Draw at positions 1, 2, 3, &c., on *b*, perpendiculars from the base line A B, in height equal to the height of the distance-pressure diagram *a* at positions 1', 2', 3', &c., of the crank pin, and join the tops of these lines by a curve. Then this curve will give the forward-pressure line of the time-pressure diagram. A similar method is used for the back-pressure line. The same construction applies to the converse case of converting a time-pressure into a distance-pressure diagram.

(1) Taking first examples of simple theoretical diagrams, and considering the forward or driving pressures only, it will be clear that if the steam is carried through the whole length of the stroke without expansion, then the two kinds of diagrams will in each case be a rectangle, and their mean pressures will be the same. Figs. 26 to 33 are the upper lines of theoretical indicator diagrams for various points of cut-off. The expansions are assumed hyperbolic, with a clearance space of 7 per cent. The full-line diagram is the true or distance-pressure diagram. The dotted line shows where the time pressure departs from the distance pressure. The

* The Institution of Mechanical Engineers.

shaded area represents the difference between the two. The following table shows a summary of the differences between the two diagrams tor a series of cut-off points between 0·2 and the end of the stroke.

TABLE I.

Point of cut-off.	Percentage difference reckoned on the mean absolute forward pressure.
0·2	+ 2·9 per cent.
0·3	− 1·4 " "
0·4	− 3·5 " "
0·5	− 2·9 " "
0·6	− 3·4 " "
0·7	− 2·6 " "
0·8	− 2·1 " "
0·9	− 1·1 " "

Average percentage difference throughout the range from 0·2 to end of stroke = − 1·88 per cent.

Fig. 34 shows the same facts by means of the curve A B. The difference intercepted by the vertical between the 100 per cent. line, and the curve A B through any point of cut-off on the base line, represents the difference per cent., at that cut-off, between the two kinds of mean pressure for the forward or driving stroke of the piston. Figs. 35, 36, and 37 show further results under various conditions.

Fig. 38 shows that if the top line of the indicator diagram slopes uniformly from admission to release—which is the tendency, more or less, in high-speed engines—then the positive area which increases the time-pressure diagram in the first half of the stroke is neutralised by the negative area in the latter half of the stroke, and the two means are in this case equal to one another. Considering the back-pressure line, it will be seen from Figs. 39 to 42 that the compression corner introduces a more or less large difference between the time pressure and the distance pressure for the bottom line of the diagram, and that the larger the compression the greater the difference between the two. The full lines of the Figs. 39 to 42 are the bottom lines of the diagrams as they would be taken by an ordinary indicator. The dotted curve is the time-pressure curve. The shaded area shows the difference between the two, and represents the amount by which the time pressure differs from the distance pressure. Where a large compression occurs with an early cut-off, as in link-motion engines, then both the upper and lower lines of the diagram show a high reading on a mean-pressure gauge, but being both plus results the errors tend to neutralise each other—Figs. 43, 44, and 45. Fig. 43 is the indicator diagram when the valve gear is linked up to nearly mid position. Fig. 44 is the top line of the diagram, and Fig. 45 is the bottom line. It is here seen that for this somewhat extreme case the error between the gauge reading and the true mean pressure is the same in kind for both the top and bottom lines of the diagram, and that the net difference is − 1·86.

(2) Turning now from theoretical to actual diagrams, the relation between the two kinds of diagrams taken from indicators A and B

TABLE II.—*Successive Trials, Taken November 25th*, 1898.

Number of trial.	Forward. Reading by forward pressure gauge. Abs.	Forward. Mean forward pressure by indicator. Abs.	Forward. Difference.	Back. Reading by back pressure gauge. Abs.	Back. Mean back pressure by indicator. Abs.	Back. Difference.	M.E.P. Time.	M.E.P. Distance.	Differences.
Block at the End of the Link.									
A	34·7	35·5	−0·8	13·7	14·5	−0·8	21·0	21·0	0
B	32·7	34·6	−1·9	13·5	14·0	−0·5	19·2	20·6	−1·4
C	39·7	41·5	−1·8	18·2	19·4	−1·2	21·5	22·1	−0·6
D	40·7	41·8	−1·1	17·7	18·5	−0·8	23·0	23·3	−0·3
E	44·7	45·9	−1·2	18·7	19·2	−0·5	26·0	26·7	−0·7
F	44·7	46·6	−1·9	18·7	19·2	−0·5	26·0	27·4	−1·4
	Mean		−1·5 or −3·8 %			−0·7 or −4·2 %			
First Grade Expansion.									
G	39·8	42·6	−2·8	21·1	22·2	−1·1	18·7	20·4	−1·7
H	40·2	41·9	−1·7	21·5	22·2	−0·7	18·7	19·7	−1·0
J	46·0	47·6	−1·6	23·7	23·5	+0·2	22·8	24·1	−1·8
K	45·5	46·7	−1·2	24·2	24·5	−0·3	21·8	22·2	−0·9
L	51·7	52·6	−0·9	25·2	25·5	−0·3	26·5	27·1	−0·6
M	50·5	51·4	−0·9	25·7	26·4	−0·7	24·8	25·0	−0·2
	Mean		−1·5 or −3·3 %			−0·5 or −2·1 %			
Second Grade Expansion.									
N	50·2	52·0	−1·8	35·2	33·8	+1·4	15·0	18·2	−3·2
O	50·2	51·7	−1·5	36·0	35·5	+0·5	14·2	16·2	−2·0
P	53·7	54·3	−0·6	36·2	35·1	+1·1	17·5	19·2	−1·7
Q	54·7	55·7	−1·0	37·0	36·1	+0·9	17·7	19·6	−1·9
R	55·7	56·7	−1·0	36·7	35·8	+0·9	19·0	20·9	−1·9
S	55·2	56·3	−1·1	37·7	37·6	+0·1	17·5	18·7	−1·2
	Mean		−1·2 or −2·2 %			+0·8 or +2·2 %			

Mean difference throughout the whole range forward = −3·1 per cent.
" " " backward = −1·4 "
Net difference " " = −1·7 "

respectively, Fig. 16, was obtained over a full range of powers. Figs. 46, 47, and 48 are examples of those obtained by the ordinary indicator, and Fig. 49 represents a corresponding time-pressure diagram. The relation between the two is shown, Fig. 50, by means of curves as percentage of the true diagram. It will be seen that the forward pressure line of the time-pressure diagram is always a little low, averaging throughout the trials here given a difference of − 3 per cent. The back pressure is shown by the short line to the right of the figure and averaged 5·5 per cent. above the true back pressure. The shaded areas marked 1 and 2, Fig. 49, distinguish between the compression area (1) and the lead area (2) on the back-pressure line of the diagram.

Trials of the mean-pressure indicator.—For the purpose of determining the true ratio between the indicator and the mean pressure instrument for any given engine or type of engine, if ordinary indicator diagrams be taken at varying loads, and the result be then compared with the reading by the gauges of a mean pressure instrument, the relation between the two can be noted, and the average difference throughout the range of loads determined once for all. The extent of this difference in practice may be seen from the following series of trials made on the experimental engine at University College, Sheffield. The engine is of the marine type, with compound cylinders 10in. and 18in. diameter, and 12in. stroke, fitted with a link motion valve gear and a surface condenser. Average revolutions 100 per minute, boiler pressure 80 lb. per square inch. The indicator diagrams, Figs. 46 to 48, are sample diagrams taken during the trials, and are numbered by letters to correspond with the letter number of the trial. The experiments were made on the high-pressure cylinder of the engine working under light, medium, and heavy loads, and under varying ranges of expansion, numbered, full steam, first grade, and second grade. The indicator diagrams were taken with Tabor indicators, the springs of which were tested before and after the trial and found correct. The pressure gauge readings were measured by means of a Schäffer and Budenberg duplex standard test gauge for the driving pressures, and by a specially standardised large dial gauge for the back pressures. From Table II. it will be seen that the readings of the forward and backward pressure gauges when compared with the indicator diagrams showed an average difference of − 3·1 per cent. for the forward pressure, and of − 1·4 per cent. for the backward pressure, or a net difference of − 1·7 per cent. If it is desired to avoid the use of factors, the forward and backward pressure gauges may be graduated as shown in Fig. 20, Plate 4, the scale being increased by the required percentage of the absolute pressure. The true mean effective pressure may then be read direct from the gauges without any further correction by taking the difference between them to within a limit of error not greater than 1 per cent. It is probable that this average percentage correction will vary for different types of engines, but experience with the instrument will determine the factor or gauge correction necessary for any given type.

In order to obtain accurate readings by means of a pressure gauge, such gauge must (1) be properly constructed; (2) be properly used. That a large number of the pressure gauges in ordinary use in practice are more or less unreliable is well known, but it will be admitted that such gauges, of the unreliable class, have not been constructed for the purpose of extremely accurate measurements, and have not received that care in the process of manufacture which is necessary to enable them to be classed as "instruments of precision." Their deficiencies are usually not due

Fig 43

Fig 44 *Forward Pressure.*

Fig 45 *Back Pressure*

Relation between Time-Pressure and Distance-Pressure.

Mean Forward Distance-Pressure = 44·04 *abs.*
" " *Time* " = 47·16 *abs.*
+ 3·12 *lbs.*

Mean Back Distance-Pressure = 37·5 *abs.*
" " *Time* " = 42·48 *abs.*
+ 4·98 *lbs.*

Mean-Effective Distance-Pressure = 6·54
" " *Time* " = 4·68
Net Difference = −1·86 *lbs.*

Fig 46 *Trial* F. *Table* 2.

Fig 47 *Trial* L.

Fig 48. *Trial* R.

Fig 49. *Time-Pressure Diagram.*

Readings by pressure gauges.—In order to obtain a reading of the mean pressure acting upon the gauge, the writer employs two throttling cocks, one close to the instrument and one more or less close to the gauge. By the use of these regulating cocks the oscillations of the finger of the gauge may be reduced to any desired degree of steadiness without interfering with the accuracy of the reading of the mean pressure. It is not unlikely that some

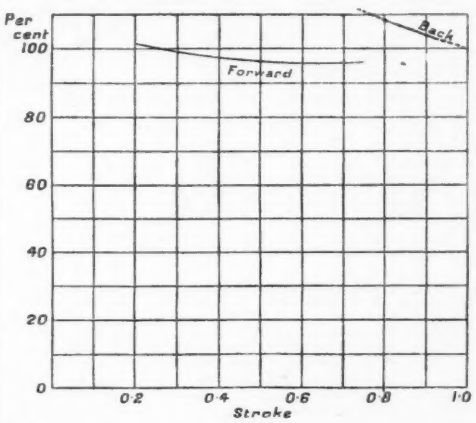


Fig. 50

engineers will object *ab initio* to the arrangement described in this paper, seeing that it is proposed to obtain such an important value as the mean effective pressure in an engine cylinder by means of an appliance so unreliable as the pressure gauge is said to be, by some authorities, and still more so when it is proposed to throttle the steam supply to the gauge, as has just been described. But in answer to these objections the writer desires to give the results of his own experience, as having himself been in doubt as to the accuracy of gauges and the effect of throttling, he has made many hundreds of experiments in order to test the extent of the error to be expected, and he has come to the conclusion that readings by a pressure gauge may be obtained which are as accurate, as consistent, and as reliable as by any known instrument for the measurement of pressure, not excepting the best of indicators; also that the throttling, when properly applied, does not endanger the accuracy of the reading, but, on the contrary, gives the true mean effect of the regular successions of momentary variations of pressures acting on the gauge.

to defect in the principle upon which they are constructed, but are rather a question of quality of manufacture. But however perfectly constructed a gauge may be, it is of course necessary that it should be carefully used, if it is to be expected to give uniformly accurate readings. Probably no instrument used by engineers receives such scant attention as the pressure gauge, and while some of our measuring instruments must be carefully cleaned, oiled, and set, before we may have a single measurement, the pressure gauge may be dirty or rusty, or hot or cold, or its syphon may be empty or full, but under all these conditions it is expected to be equally accurate.

Pressure gauge syphons.—The importance is admitted of maintaining a column of water in the syphon of the pressure gauge to keep the gauge cool, so that its readings may be consistent, and so as not to subject the gauge to high or variable temperatures. It is generally supposed that if the gauge has a syphon there is always water in it, and that when the syphon is once full of water, the water is easily retained therein, but these assumptions are not warranted by the facts of the case. The water will disappear from the syphon from various causes: (1) If there is the smallest leak in the gauge end of the syphon, then the water is all gone in a minute or two by being blown out by the steam, though the leak may be almost imperceptible. (2) If the pressure to which the gauge is subjected is a variable one, as is the case when the gauge is attached by its syphon to the valve chest of an engine regulated by a throttling governor; then the water will disappear from the syphon as usually constructed in a few minutes, especially on a sudden reduction of load, and consequent fall of pressure, in the same way that water in the engine cylinder disappears during expansion and exhaust. (3) When the gauge is liable to be subjected to a vacuum, as is the case when it is attached anywhere on the engine side of the throttle valve; then if the throttle valve is closed by the governor or by hand, while the engine continues running, especially if it is a condensing engine, the engine becomes an air pump and the water in the syphon is displaced by the expanding air initially contained in the spring tube of the gauge and its connections. Thus if the pressure in the engine falls to 3lb. absolute, the volume of water displaced in the syphon equals 15 ÷ 3 = 5 times the volume of air in the gauge. If now the steam is again suddenly turned on the engine, it is certain that the gauge readings will be different from what they were when the syphons were full of water. When there is water in the syphon the syphon pipe is practically cold with a steady pressure. When the pipe is

Fig 51
Differential Pressure Gauge

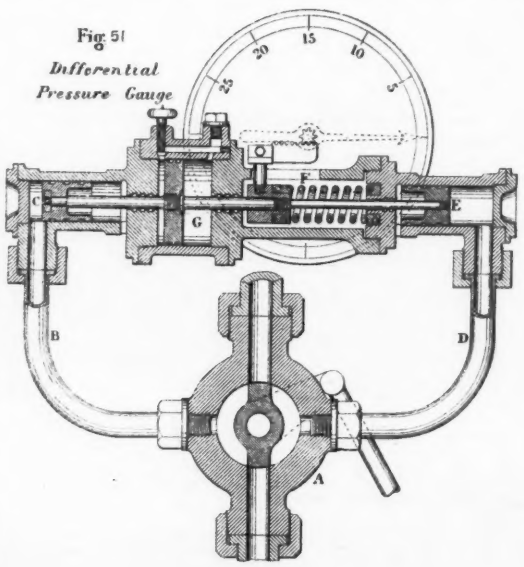
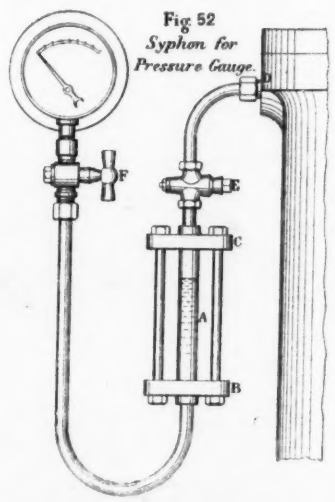


Fig 52
Syphon for Pressure Gauge.



very hot the water has probably gone from the syphon, unless it happens that the pipe is in contact with some hot metal. (4) If the gauge is subjected to a vacuum, and there is the smallest leak in the fittings at the gauge end of the syphon; then the water in the syphon is displaced by the air which enters the syphon through the leak.

To prevent the disappearance of water from the syphon.—(1) When the cause is due to the variable nature of the pressure acting on the gauge the water may be retained in the syphon by the method of double throttling already mentioned. When the mean pressure instrument was first constructed only a single cock was fitted to

CONTINUOUS MEAN PRESSURE INDICATOR

(For description se page 601

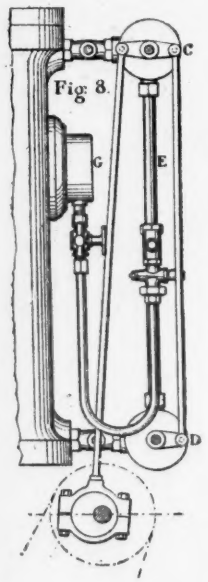


Fig. 8.

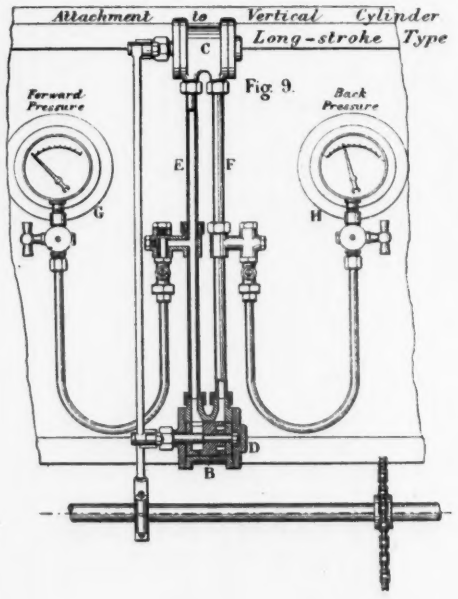


Fig. 9.

Rotating Valve for High Speeds

Fig. 10.

Fig. 11.

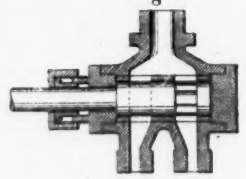
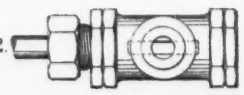


Fig. 12.



Valve for Long-stroke Type.

Fig. 13.

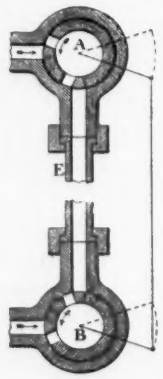


Fig. 14

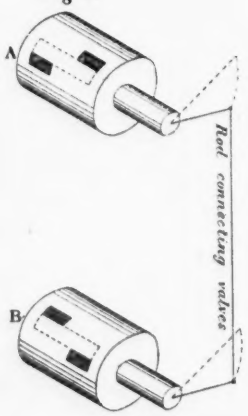


Fig. 15.

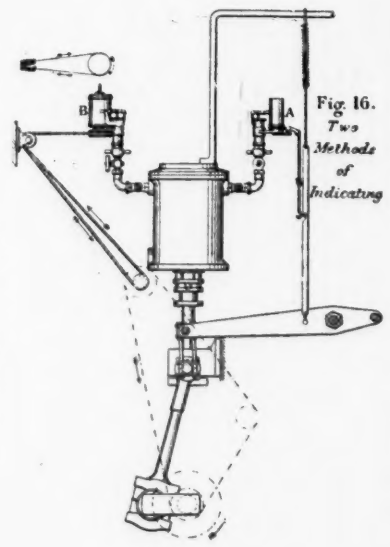


Fig. 16. *Two Methods of Indicating*

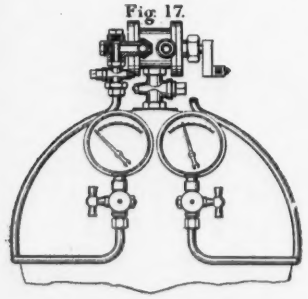


Fig. 17.

Attachment to Horizontal Cylinder
Long-stroke Type.

Fig. 18.

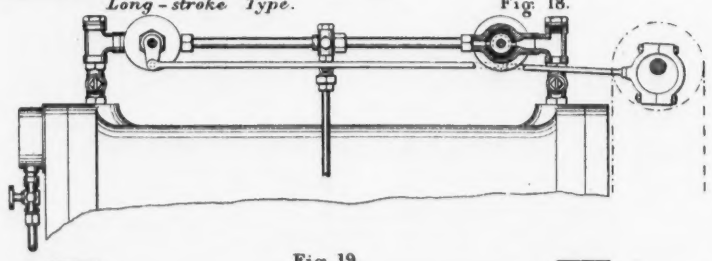
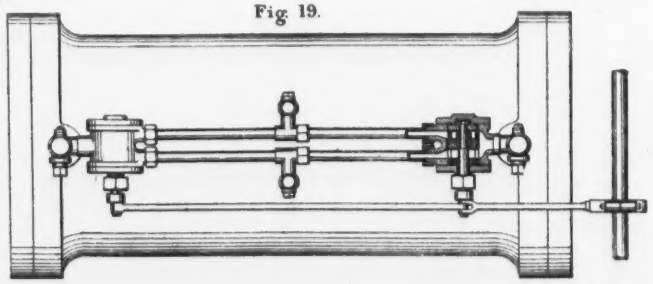


Fig. 19.



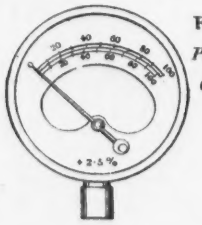


Fig. 20 *Pressure Gauge.*

Fig. 21
Ordinary Indicator attached to Mean Pressure Instrument.

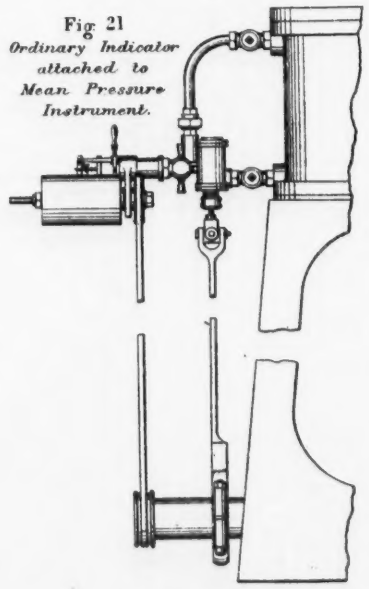


Fig. 22. *Forward and Back Pressure (not separated).*

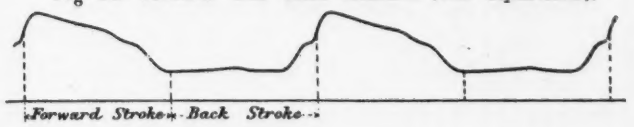


Fig. 23. *Forward Pressures, top and bottom.*

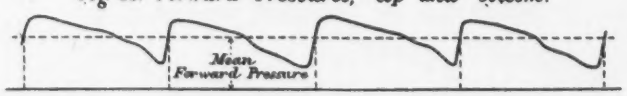
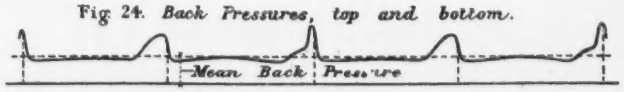


Fig. 24. *Back Pressures, top and bottom.*



the syphon of each pressure gauge,* and great difficulty was found to keep the water in the syphon. Many devices were tried to overcome this difficulty, but without avail. A second cock would have been fitted at an early period of the experiments, at the end of the syphon farthest from the gauge—which, when throttled, would instantly have stopped the trouble—but for the fact that the writer set out with the notion that if the throttling of the syphon cock was a throttling of water the pressure would be transmitted to the gauge undiminished, but that if the throttling took place in the steam a loss of pressure would follow, and the reading of the gauge would be low. This erroneous notion cost about twelve months' experimenting to try to discover how to do without the use of water in a syphon.

One of the devices tried by the writer to overcome the difficulty may be of interest. A differential pressure gauge was constructed as shown in Fig. 51. The driving pressure steam was admitted from the mean pressure indicator valve box A by the pipe B against the piston C. The back pressure was admitted by the pipe D against the piston E. The pistons C and E were attached to the same rod, which was made an easy fit to prevent friction as far as possible, and the movement of the piston was regulated by the indicator spring F. To prevent violent motion of the pistons a dash-pot G was added which was filled with oil, and its piston was also made to work quite smoothly. Holes were made beyond the pistons C and E to allow of the free escape of any steam which might pass the pistons. The method of transferring the movement of the pistons to the finger of the gauge will be understood from Fig. 51. This instrument was not satisfactory, as it was not sufficiently sensitive, and a further attempt was made to improve the action of the water syphon.

Fig. 52 shows the arrangement employed for experimenting on the effect of double throttling. A short water-gauge glass A is secured between two plates B and C held together by bolts. The glass is connected at the top with the engine cylinder D by the pipe as shown, and at the bottom of the glass the gauge pipe is attached. There are regulating cocks at E and F. When the cock E is opened wide, and the engine is running, the change of pressure in the cylinder between the driving and the exhaust stroke caused a more or less violent agitation of the water in A, being the more violent as the range of pressure was greater. When the range of pressure was not more than about 10lb., the water in the glass was quiet, but when the range of pressure exceeded this—by increasing the load on the engine—agitation again began. The action appeared to be due first to the heating of the water in the tube by the rush of steam, mixed with globules of hot water, into the tube; and, secondly, to the re-evaporation of the heated water when the pressure fell during expansion and exhaust in the cylinder. It is not possible to give numerical data as to the effect of different ranges of pressure, because the behaviour of the water was most erratic. Sometimes with a given range of pressure in the engine, the water was violently agitated, and would disappear from the glass in a few minutes; in other cases it would remain quiescent in the glass for hours, though the conditions appeared to be unchanged. Then it would suddenly commence to boil, and to disappear without any apparent cause. But in all cases of agitation of the water in the tube A, when the cock E was throttled down the agitation immediately ceased.

The amount of throttling of the cock E which was necessary to stop the agitation still left a fairly large movement of the gauge finger across the scale, and the final adjustment for steadying the finger to the smallest possible movement was obtained by throttling the cock F. Throttling the cock E had no effect on the pressure reading by the gauge unless the throttling was carried too far. It was not necessary in order to stop the ebullition to throttle the cock E so far as to reduce the pressure. If any doubt remained as to whether the cock E was throttled too much, a little more opening of E would show at once whether such was the case. But it is only necessary to move E sufficiently to stop the ebullition and consequent disappearance of the water, and this leaves a good margin before the throttling of E is excessive.

With such an arrangement the effect of suitably throttling the cock E is to automatically fill up the syphon, if partly empty from any cause, and the water in the syphon will thus reach as far as the cock E when the apparatus has been at work a short time. In this way the problem of keeping the water in the syphon continuously and free from agitation was solved, and there is now practically no difficulty in obtaining a constant and accurate reading of the mean pressure by gauges subjected to variable pressures.

(2) When the cause of loss of water in the syphon is due to the gauge being subjected to a vacuum a type of gauge is preferable from which the air in the Bourdon tube has been excluded, and the tube filled with liquid to its extremity; there is then no air to expand in the tube to expel the water from the syphon. To sum up:—(1) The instrument here described gives a correct record of the mean time pressure. (2) The mean time pressure bears a definite ratio to the mean pressure as given by an ordinary indicator. (3) The correction may be made by the use of a factor, or by a corrected scale on the gauge dial. (4) Pressure gauges, when properly made and properly used, may be relied upon to give accurate readings. In conclusion, the author wishes to acknowledge his indebtedness to his assistant, Mr. J. W. Kershaw, M.Sc., who has rendered considerable help in carrying out the experiments.

LONDON WATER SUPPLY.—It is rumoured that the report of the Royal Commission on the Water Supply of the Metropolis will be made before the end of the year.

INSTITUTION OF MECHANICAL ENGINEERS.—On Monday, December 11th, a meeting of the graduates of the Institution was held at the Institution House, Westminster. Mr. William H. Maw, Member of Council, occupied the chair. Mr. W. B. Cleverly, graduate, read a paper on "Works Management, Methods of Quick Production of Repetition Work." The author dealt chiefly with some useful and very interesting methods for the rapid production and repetition of finished brasswork. He first impressed the necessity of being able to price quickly all kinds of brasswork. Much of the work could be done well and cheaply by boys. The boys should be kept at the same or similar jobs. They were in all cases paid by piecework. For finishing small brass castings good steel cutters were used, which lasted for 400 castings. The tapping machines used could tap 600 ¼in. holes in ⅜in. metal in an hour. For burnishing, a capstan head, with three hard steel rollers, 1½in diameter was used. One traverse was sufficient. For filling porous brass castings oatmeal was employed. The author then described the methods of finishing screwed stays for locomotive fire-boxes. These were made from round rolled bars, cut to finished length, and centred by a boy, who could centre 400 in an hour. Longitudinal slots were cut in the shank to permit irregular expansion of the inner and outer fire-box. The slots were cut in a milling machine with a circular saw. The stay was carried by an eight-pointed centre. A man could produce 100 of these stays, each with four slots, in an hour. Screw threads usually eleven or twelve per inch. Hand-cut chasers lasted the longest. A man could produce twenty per hour from ⅜in. steel. Hard bronze was used for patterns for castings in large numbers. The author had found hard bronze to contract very slightly in the mould. A long and interesting discussion took place, in which Messrs. Maw, Chapman, Worthington, Duncan, and others took part. Mr. Maw described some brass clack-boxes, which were finished by a complete automatic machine in seven minutes, and which ordinarily would take two hours and three-quarters to finish. Mr. Worthington thought that such automatic machines could only be advantageously applied when running for at least a week without changing the tools. A hearty vote of thanks to Mr. Cleverly for his excellent paper terminated the proceedings.

* See "Proceedings" Institution of Mechanical Engineers, 1897, page 347, and plate 76.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

(*Continued from page 594*).

THE EFFICIENCY OF STEAM ENGINES.

SIR,—I find in your issue of October 13th Mr. Bryan Donkin's compilation of steam engine trials and data, the most valuable and extensive that I have yet met with, and I have taken the liberty to present it to the American Society of Mechanical Engineers, at the approaching conventions, in connection with a paper, "The Steam Engine at the Close of the Nineteenth Century," in which are given what I think may prove interesting data and discussions of the last "record-breaking engine" on this side the Atlantic, giving a duty of nearly 163,000,000 foot-pounds per 1,000,000 thermal units, which engine appears in Mr. Donkin's list as No. 5.

It should be noted, in studying this tabulated compilation, that the "order of merit" is not, strictly or properly, that of weight of steam per indicated horse-power per hour, as assumed in arranging that table, and as given in Column 11; but it must be taken, especially where steam pressures and feed-water temperatures vary as greatly as they actually do in this list, as given in the 13th, 14th, and 15th columns, measuring by the heat consumed per unit of power or by work, as in the "duty" column. Where, as in Table No. 2, these figures are not given, the relative standing of the engines cannot be given unless it is known that they employ substantially the same steam pressure, and have the same temperature of feed, the principal condition being similar temperatures of feed-water.

In comparing the engines, considered apart from the boilers, a common temperature of condenser should be assumed, if the engines are of such construction, and so operated, as to permit it. As a matter of fact the Pittsburgh engine, now just reported, only takes over 909 thermal units per pound of steam; a Carnot engine in the same place would take over but 840; while 1000 and 1100 thermal units are more usual figures. This accounts for the fact that the "record-breaking engine" uses 12·26 lb. of steam where the record of engines on this score is held by the Hall and Treat engine at 9·6, or, among other than experimental engines, by Mr. Leavitt's Chestnut Hill engine, which does not appear in the table, at 11·22 lb. per indicated horse-power per hour.

In the table, No. 3 engine has its figures for steam consumption transposed. The official figure was 11·678 lb., and the unofficial figure was 12·15. This engine, at its date, was the holder of the record for the world, and still stands well up, when its low steam pressure is considered.

It should further be noted that it has for many years been customary in the United States to reckon "duty" on the basis of 100 lb. of fuel, the "cwt." being practically unknown in this country. Our ton is usually the "round ton," and our people seem inclined to eliminate the superfluous figures in all computations, as they similarly eliminate superfluous work in productions of all kinds.

Mr. Donkin's valuable table should be revised as to a few of its figures and its order of engines, as presented, I think; but it is a most helpful piece of work, and it is to be hoped that it may be taken as a beginning of a standing table, which shall grow as time goes on, with progressive improvement of the steam engine.

R. H. THURSTON.

Directors' Rooms, Sibley College, Cornell University,
Ithaca, N.Y., November 20th.

ECONOMICAL HAULAGE.

SIR,—In your issue of week before last, I notice correspondence on "American *v.* British Railways," with a leader on the same subject, in which you ask for information as regards collection of grain for conveyance in the huge cars on American railroads. As I spent some four or five months in the States last winter—November to March—with friends, some of whom were producers, I had the opportunity of witnessing the manner this was carried out. With respect to British railways, their coming down to anything like a level with charges for carriage in the States is utterly impossible, as the collection and distribution of goods is so dissimilar. Virtually, the wheat, &c., is put upon the freight train free of cost. An agent of the large city firms, in communication by telephone with the latter, is placed at some of the larger wayside stations; the farmers travel distances of seven, ten, or perhaps a dozen miles, inquire price, pass on to weighbridge, and then take their turn to the raised dock by the side of the car; a shoot is then placed on the side of the wagon or sleigh, as the case may be, down which he empties his two-bushel bags directly into the car itself, where it is carried loose; thus the grain is placed on board free of expense to the railroad company. At larger places, of course, there is an elevator, to which the grain is delivered by the growers' team from the surrounding district.

Then, again, the cost of distribution is in no way comparable with the English system; think what the latter entails on English companies in every town throughout the country. The numbers of men, horses, drays, &c., employed, food, stabling, and other accommodation required, involve an enormous expenditure. The American plan is for merchants or tradesmen to provide for their own delivery.

The distances are also very much greater between town and town, thirty, forty, or even fifty miles is no great distance for great centres to be situated apart, giving longer hauls.

There is, thus, not the slightest probability of British charges ever coming down to the American level.

In conclusion, I might say the great comfort experienced in winter travelling on the American railroads was simply delightful, whilst on our return to England the contrast appeared by comparison the perfection of misery. W. HOLMES.

Balderton, Notts, December 11th.

FAST TRAVELLING IN THE UNITED STATES.

SIR,—The letter on page 577 on this subject, signed by Mr. Henry G. Joy, A.M.I.C.E., quite unintentionally gives so many wrong statements that someone is needed to give the facts, as it is thus that false history is made.

Nothing is more dangerous than to quote the daily Press as an authority on technical matters, especially where railways are concerned, and Mr. Joy's cutting from the *Atlantic City Daily Press* affords a striking warning. The paragraph relates to the famous work done by the "Atlantic City Flyers," which for two years have been timed to do the start-to-stop run from Camden to Atlantic City in 50 minutes for a distance of 55·5 miles, or a booked speed of 66·6 miles an hour inclusive. This, as we know, has been done with great ease, the train never being late on terminal, and generally before time.

The officials of the Philadelphia and Reading Railroad have, however, been experimenting with their famous locomotive No. 1028, to see whether she could keep time on this schedule with very heavy trains, provided she had enough water. Accordingly she has been given a 6000-gallon tender, and is being severely tested.

Now comes the chance for the half-informed reporter to revel in sky-striking adjectives, and to fuddle us with figures, either grossly exaggerated or utterly commonplace. This time he goes on the latter tack:—The run of 55½ miles is done in 51 minutes inclusive, with an evaporation of 5348 gallons of water, and "some idea of the immense weight of the load and the length of the train pulled by No. 1328 can be obtained when reduced to plain figures. The coaches in the train are extra heavy, and weighed 18 tons each, or a total of 180 tons; they are 62ft. long, or a total of 620ft."

It would be difficult to cram more errors into the same space if one tried. An extra heavy U.S.A. coach weighing 18 tons would be a curiosity, seeing they have nothing but bogie coaches, an extra heavy East Coast Joint Stock six-wheeler weighs as much. And some French four-wheelers are 17½ tons; and how an extra heavy coach 62ft. long can be kept down to 18 tons, is one of those things "no fellah can understand." Equally puzzling is a locomotive which requires 5348 gallons of water to haul 180 tons over 55½ miles. Considering that this same engine has for two years been running day after day with 206 and 234 tons of cars the 55½ miles in times like 45½, 46½, &c., minutes—or 73, 71·2, &c., miles an hour, start to stop—it is clear the paragraph is much out.

The fact is that the average weight of the cars on this route is 33 tons, and if they were using ten of the extra heavy "Club" and Pullman cars for these trials I calculate the train at about 342 tons—empty—behind the tender. But it seemed to dawn upon our reporter that he had given something away, because he adds:—"The trainmen stated were a test of speed to be made they were confident that 1028 could haul this train of ten cars over the Atlantic City Division in thirty-five minutes." That is over 300 tons weight at 95 miles an hour inclusive! When we reckon that all these trains have to start slowly out of Camden and slow up on entering Atlantic City, as they run through crowded streets, and that the whole run is very short, it is evident that in spite of their vastly superior brakes, track, signals, and locomotive construction, a great deal of salt will be needed before this can go down with us, seeing 1028 has only 1835 square feet of heating surface.

NORMAN D. MACDONALD.

Edinburgh, December 11th.

THE TRAINING OF ENGINEERS.

SIR,—The "Grievances of Young Engineers" may, perhaps, be borne by them with greater equanimity if I may be allowed to point out that a "definite status in his profession" awaits every young engineer of average industry and respectability. This professional status is offered to the young engineer by the Institution of Civil Engineers. This valuable Institution stands practically *in loco parentis* to the young engineer. It has been incorporated by Royal Charter for the express purpose of "promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer." To do this it will obviously be anxious to bring into its parental embrace all engineers, whether old or young. By referring to the bye-laws of the Institution it is seen that the way into the Institution is made very easy for all engineers who desire to enter. Thus, it is stated that engineers over thirty years old, who can show five years of responsible work, are entitled to the full membership of the Institution; and that educated young engineers of twenty-five years of age may become at once Associate Members of the Institution in one of three ways, viz.:—(1) By passing the Institution examination in writing, English, theoretical and elementary applied mechanics, &c. (2) If the young engineer has had five years' work, he may write a technical paper. (3) He may show that he knows and has done enough already, and avoid either examination or paper.

So it is seen every one who is engaged as an engineer, and has had five years' work, is entitled, according to the constitution of the Institution of Civil Engineers, to become—if he is thirty years old—a M.I.C.E; and if twenty-five years old, an A.M.I.C.E.

The Council, who represent the members, see that the bye-laws are carried out, and engineers admitted in accordance with them—and admitted freely, for the Institution has a Royal Charter, and is *pro bono publico*. It is not a trades union to enhance the value of those belonging to it. The Institution is really an engineers' club to promote professional intercourse, and to raise the standard of the members, and to promote the exchange of ideas and opinions on professional subjects by means of papers, lectures, and visits to works. Of course, a solicitor or a doctor must be qualified according to law, but engineers unfortunately require no such qualifications, and most of them never passed a technical examination in their lives. While the membership of the Institution of Civil Engineers is no qualification, yet it marks the young engineer as one who takes an interest in his profession, and shows he has done some few years' work.

I feel sure that many hundreds of young engineers, and old ones too, who have not yet taken advantage of the promise held out by the Institution in its bye-laws, to give them its membership, will learn very much that will be useful to them by doing so at once.

December 12th. ——— ἑβρηκα.

HIGH FURNACE GASES.

SIR,—I should be interested to learn from Mr. B. Donkin whether the waste gases from silver or copper high furnaces can be used, and what is the lowest heating value of gas that would be suitable. I am told that very often gas is so poor from high furnaces making iron that the gas will not keep burning in the flues of steam boilers, so that I do not understand how it can keep continuously burning in gas engine cylinders. The discovery of the practicability of using these waste gases in gas engines is one of, if not the most promising events in modern engineering, and the discoverer deserves every recognition and reward.

Chester, December 12th. EXMOS.

LOCOMOTIVE LIFE-GUARDS.

SIR,—If the life-guards of a bogie locomotive are placed on the main frames, instead of on the bogie frames, they will not remain vertically over the rails when the engine is traversing a curve. Some engineers get over the difficulty by spreading the points of the life-guards to a width of about 3in.

December 9th. LOCO. PRENTICE.

BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.—Mr. W. H. Brothers having resigned his position as secretary to this Association, the Council have invited Mr. Percy Griffith, C.E., of Westminster, to take over the duties for the twelvemonths commencing November 30th. As some difficulty has been experienced in finding a suitable successor to Mr. Brothers, Mr. Griffith has agreed to accept the appointment, and it is requested that all correspondence with reference to the Association should in future be addressed to him at the offices of the Association, 54, Parliament-street, Westminster. It has been decided to hold the winter meeting in February next in London, full particulars of which will shortly be announced. In accordance with a recent resolution of the Council, the ballot for President and officers to take office next summer will be taken at this meeting. Several valuable and interesting papers have been offered to the Council for reading and discussing on this occasion.

RATHER AGGRAVATING.—In the midst of much-heated discussion of the political expansion of the United States, it is refreshing to see with what rapid strides the commercial expansion of the country is taking place in every part of the world. This is a species of invasion, upon the ethical and economical aspects of which we are all pretty well agreed; and on the receipt of each bulletin announcing the success of the foreign representatives of our great industrial concerns in winning orders against strong local competition, we may well feel a touch of patriotic pride. The latest and most significant instance of our invasion of foreign territory is furnished by the contracts which several American firms have secured for furnishing the plant and equipment for the Glasgow municipal tramways. The National Cable and Conduit Company is to supply and build the cables and conduits; the E. P. Allis Company, the engines; the General Electric Company, the electric fittings; and the first one thousand cars are also to be supplied by an American firm. The total value of these contracts is said to be in the neighbourhood of 15,000,000 dols.—*Scientific American.*

INSTITUTION OF ELECTRICAL ENGINEERS.

INAUGURAL ADDRESS.

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S., President, delivered on November 16th, 1899.

(*Concluded from page* 580.)

RETURNING to the question of electric tramways, the problem of the hour is the equipment of busy City thoroughfares, where for obvious reasons overhead wires are inadmissible. To all the three possible methods that dispense with overhead construction, viz., by accumulators carried on the car, by use of slot conduits in the road, and by use of surface contacts, objections are not wanting. Accumulators are found too heavy and too short-lived to be satisfactory. Conduit constructions are objected to as too costly, and as interfering too much with the roadway, while to surface contacts there is brought the terrible indictment—worse than any against the conduit—that nobody has had experience of them. You are aware that in this question of surface-contact systems of tramways I am an interested party, and cannot be expected, even in a presidential address, to speak dispassionately. Yet you have never expected your President to banish from his inaugural address the topics to which he has devoted his thoughts, his energies, his time, or his resources. And with the examples before me of other presidents who have spoken of their own work, I take the liberty of speaking of mine. A paper dealing with some aspects of surface contact working was read by me at the Bristol meeting of the British Association, and in January last you listened here to a paper on some other points by Mr. Miles Walker, my former assistant, and partner in this matter. We have, indeed, worked out several different systems, of which the earlier only have yet been publicly described. We are at work on modified plans, the result of our experienced gained on our short experimental line at Willesden; and before long we expect to demonstrate the advances we have in hand. Meantime we are not alone in the field. Since the time when the late Dr. Hopkinson proposed his original plan, many others, including Mr. Wynne, Mr. Holroyd Smith, Mr. Esmond, and Messrs. Johnson and Lundell, have suggested various new methods. Three years ago Dr. Hopkinson wrote of one of these methods that he "would not hesitate to approve its adoption in any town in which overhead conductors were inadmissible;" adding that he had "not the least doubt that it would work thoroughly, effectively, and safely." A good deal has happened since then, and much experience has been gained. But there remain not only in London, but in many provincial cities, crowded thoroughfares where overhead construction is absolutely out of the question, and where a slot conduit would be almost equally objectionable. It is some years since Mr. J. Love equipped slot-conduit lines in Washington and Chicago. It is now most significant that in three great capitals—New York, Berlin, and Paris—the electric tramways are being largely extended without overhead wires. New York and Berlin are putting down slot conduits; New York, most expensively, as if the object were to put as much cast iron as possible into the roads; and the conduit at every 15ft. is furnished with pairs of hand-holes, the covers of which interfere with the surface quite as much as any surface-contact system, to say nothing of the interference of the central slot or of trouble about drainage. In Paris, on the other hand, where a tentative surface-contact system has for about a couple of years been tried with moderate success, no fewer than 63 kiloms. (about 48 miles) are now being equipped by Mr. Diatto on his surface-contact plan, which has been in successful operation on a small scale at Tours. Surely, then, if a method of surface contact can be shown which is at once simple, safe, and not too expensive, there is every reason to urge on engineers and municipal authorities its adoption. Thanks to the criticisms—some of them passed in this place—with respect to possible difficulties likely to arise from the use of underground coils, from mercury switches, and from surface leakage around the contact studs, improvements have been worked out which largely, if not wholly, remove the fears that have been expressed on these grounds. As contrasted with the conduit, a surface-contact system has the advantages of much lower prime cost, of less interference with the roadway, and of not requiring any drainage arrangements. On long lines that run out into the country it can be operated with the same cars that carry trolley poles for use in the suburban part of the track. Those cities and towns which, like London, Birmingham, and Cambridge, have waited before erecting overhead lines, will have justified their waiting attitude when they can point to examples of the successful surface-contact roads at Monaco, at Tours, and lastly at Paris.

Time forbids me to dwell further upon this topic; it precludes me likewise from entering upon a number of other topics of great interest, such as the development of the single-phase motor; the establishment of electric time-services by synchronised dials throughout buildings, blocks of offices or whole municipalities; the use of prepayment meters; the recent developments of electro-metallurgy; the revolution in chemical manufactures by the use of electric methods; the use of aluminium wires in place of copper wires as conductors; and last, but not least, seeing that Atlantic liners can now signal their presence when fifty miles from port, the progress of telegraphy without communicating wires. In all these many directions there may be noted pronounced tendencies towards development along distinct lines of progress, and some of these topics will doubtless form the subjects of discussion at our meetings during the session now beginning. I venture also to express the hope that the question of the distribution of electric energy on the large scale may be brought before our members for discussion. Nothing can be more helpful to the industry generally, just at present, than the free discussion of a topic which is likely again to engage the attention of Parliament, and which ought to be discussed from the standpoint, not of restricted parochial or municipal interests, but of its bearing on the wider interests of national and public economics, and of the industry at large.

In commemoration of the centenary of the discovery of the pile, by Alessandro Volta in 1799, the city of Como, his birth place, has this year held high festival. Beyond contest this discovery of a means of generating chemically a steady electric current constitutes the starting-point of the entire modern development of the science of electricity. Though that modern development turns upon the subsequent discoveries and inventions of others—the discovery of the magnetic properties of the current by Oersted, the invention of the soft-iron electromagnet by Sturgeon, the discovery by Faraday of the fundamental-principles underlying the dynamo and the transformer, together with many others of lesser moment—it still remains to betrue that to the genius of Volta we owe the initial impulse. His memorable letter of June, 1800, to Sir Joseph Banks, first describing the pile, marks the opening of a new epoch in the history of civilisation. Without that discovery we now possess, neither telegraph nor telephone, neither electric light nor electric power, electrotyping and electroplating would not exist. Commerce, diplomacy, warfare, and journalism would have remained in a totally different stage of development from that in which they are to-day. In brief, we should—with the modifying circumstances of the steam engine existing for power and the gas jet for light—be still living in the stage of civilisation of the eighteenth century.

The Volta centenary was commemorated at Como by the erection of an exhibition and the holding of a series of celebrations. Unfortunately the exhibition was destroyed on July 9th by a calamitous fire, in which not only a fine collection of modern electrical machinery was destroyed, but a number of Volta's original manuscripts and a considerable part of his historical apparatus perished. Happily the original pile and numerous other relics were saved, and are now enshrined in the Civic Museum of Como. Nothing daunted, the citizens of Como reconstructed their exhibition, which was re-opened in forty-two days. Amongst the Como celebrations were held two congresses; one a Congress of Telegraphists, in June; the other a Congress of Electricians, in September. No invitation to send delegates to the former was received by this Institution, and neither it nor the British Post-office was officially represented. Four English telegraphists, none of them members of this Institution, were reported as having been present. This congress, having been convened by the Italian Minister of Posts and Telegraphs, and being attended by official delegates of various European administrations, many of them telegraph engineers of the highest distinction in their various countries, it is extraordinary, to say the least, that the English Postmaster-General was not represented on the occasion. The Congress of Electricians was organised by the co-operation of the Physical Society of Italy, of which Professor Roiti, of Florence, is president, and of the Italian Association of Electrical Engineers, which has branches in Milan, Turin, Genoa, Rome, Naples, and Palermo, and of which Professor the Hon. Giuseppe Colombo is president.

At this congress, at which distinguished electricians from France, Germany, Holland, Switzerland, and Finland were present, this Institution was represented by Professor Ayrton, past-president, and by myself. The Italian physicists and electrical engineers attended in great force. The proceedings of the congress were carried on with great vivacity; and many matters of the highest scientific and technical importance were discussed in its various sessions. After the sittings were concluded, two days were devoted to visits to the large generating stations at Paderno and at Vizzola, the former taking power from the river Adda—which flows out of the Lago di Como—and supplying electric current for transmission at high voltage to the city of Milan; the latter, not yet quite completed, taking water from the river Ticino, which drains the Lago Maggiore, and distibuting its currents to the industrial towns of Gallarate, Legnano, and Somma Lombardo, within a radius of some twenty-five miles. Alike from the point of view of electrical and hydraulic engineers, these stations are of the highest interest, presenting as they do special features different from those of almost all other kindred enterprises. Our Italian brethren may well be proud of the engineers who have found the solutions for these special problems of construction, and carried those solutions to practical success.

This year is also marked by the establishment, with a Government grant, of the National Physical Laboratory for the standardising and certification of scientific instruments, and for physical research on well-defined lines. Though thus commenced on a modest scale, the circumstance marks an event of national importance.

I cannot forbear to direct your attention to another matter of public interest, and one which exercises an influence on all attempts at developing new enterprises. It is only too notorious that the whole question of financial development of new inventions is in this country in a most unsatisfactory state. The promotion of joint-stock companies under the Limited Liability Acts has become a public scandal. In the eighties a heavy blow was given to the real progress of electric lighting by the reckless promotion of bubble companies with inflated capital, causing the loss of millions of money upon foolish and worthless schemes. In the year 1882 no less a total than £23,000,000 of nominal capital was registered in electrical company schemes alone. In the nineties a similar reckless speculation has been witnessed over bicycles and automobiles. Happily electric traction has largely escaped this curse; and it will be an evil day for any of the newer developments of electrical engineering if a like craze should overtake them. There is something amiss in our economic machinery when such scandals can recur. Nothing is more familiar to those who have to deal with new inventions, or to those who as consulting engineers have to advise and report upon them, than the ever-recurring difficulty of getting them financed on a sound basis. Suppose that there is an invention of a thoroughly sound character, properly protected by patents, but requiring time and money to establish itself commercially. Suppose that there is required a capital of from £10,000 to £25,000 to put it upon a commercial basis. In the present state of public finance in this country the inventor finds himself in this difficulty. He must either raise the necessary capital privately by personal effort amongst his own friends, or he must put it into the hands of a promoter who will want to bring it out with a capital of at least £100,000. In other words, it is almost impossible to find a middle course between a purely private affair and an over-capitalised swindle. We have, unfortunately, in this country no organisation corresponding to the Industrial Banks of Germany, to the enlightened management of which the financing of sound schemes on a moderate scale can be entrusted. Much more might be said on this topic. It is one which affects not our industry alone; but it affects ours perhaps more than any other industry, because the glamour which is attached in the public mind to everything and anything electrical is made use of by the unscrupulous financier to the detriment of honest promotion.

I have already alluded to the sums of money which have been invested in this country in the supply of electricity for lighting and power, and in electric traction. According to Mr. Garcke's invaluable "Manual of Electrical Undertakings," from which I derive my figures, the aggregate subscribed capital in shares and debentures at the present date stands as follows:—

	£
Telegraphs	34,284,957
Telephones	7,729,626
Electric supply (companies)	9,265,793
Electric supply (municipalities)	8,531,167
Electric traction	20,808,959
Electric manufacturing	16,799,152
Electro-chemical and miscellaneous concerns	8,558,065
Total	105,997,716

This hundred millions of subscribed capital is much less, it is true, than that represented by the total capital invested in railways or in many other domains of British industry. But it is this electrical industry and the scientific and professional elements associated with it which our Institution represents to-day. Competing as we have to do not only in foreign and colonial markets, but even in our own home markets, with the manufacturers and engineers of other countries, it behoves us to do all we can to make our Institution of use to our members of all grades, and particularly to our younger members. One great duty which we owe to them is to furnish them with the latest information as to the progress of electrical development, the development not only of industrial undertakings, of new machinery, of new materials, and of new inventions, but also of pure science, upon which all technical developments are in truth based. From the very first year of our existence—1872—we have always issued, in our "Journal of Proceedings," abstracts and extracts of scientific and technical papers published at home or abroad. Two years ago we joined with our colleagues of the Physical Society in bringing out in the monthly numbers of *Science Abstracts* a far more complete digest of electrical progress than we were previously in a position to produce. To carry on this publication both we and the Physical Society have had to devote considerable sums, and indeed one of the reasons why we had a year ago to raise the fees paid by our students was avowedly to meet the financial burden which we had thus assumed for the pupose of disseminating knowledge. I venture to think that every penny thus spent has been a most wise outlay, and one of which we are already beginning to reap the fruits. Our members all over the country and in distant lands are thus kept informed month by month of the progress of the science; and they increasingly appreciate their connection with the Institution. I know of no means better calculated to keep our younger men abreast of the times than by putting into the hands of every one of them this admirable compilation.

But the needs of our Institution do not end with the effort to keep our members informed of the progress of science. We have other demands upon our funds of a very pressing character. The Benevolent Fund established a few years ago upon an independent basis has, though small, been available for helping necessitous members. In this connection every member of the Institution will rejoice to learn of a great and generous offer which has just been made to us. One of our honorary members, Mr. Henry Wilde, a name memorable as that of the pioneer in the sixties of the early forms of dynamo machine, both continuous and alternating, and of their application to lighting, to deposition of copper, and to the transmission of power, has offered to the Institution, and the Council has accepted, a sum of £1500 for the purpose of constituting a Benevolent Fund. I need only mention this to secure your cordial acknowledgment of the great generosity of Mr. Wilde, whom two years ago we elected an honorary member in recognition of his claims on the electrical community.

From the very beginning we have been accorded by our generous hosts, the Institution of Civil Engineers, the privilege and advantage of holding our meetings in this hall. If some of us feel that with the rapid growth of our own body the time is coming when we ought to be taking active steps toward providing ourselves with a home of our own, it is not because we are not deeply grateful for that privilege. Nay, rather the circumstance that our growth compels us to contemplate this step is a perpetual reminder of the courteous generosity which has itself been no small factor in promoting our welfare and our increase. The founding of our Building Fund six years ago was due largely to the foresight and fostering care of our then treasurer and vice-president, Sir David Salomons. At his instigation we have annually set aside such sums as we could spare from our surplus income, and our nucleus of a Building Fund stands this autumn at £5000 so accumulated. The Council has for some months been quietly prosecuting inquiries for a suitable site; and it has recently decided to issue a circular drawing attention to the Building Fund, and suggesting to members of all grades the expediency of subscribing for the next few years an annual contribution thereto. If by this means we can treble or quadruple our present fund, we shall be ready at least to begin to build when a suitable site shall have been found. And it is most earnestly to be hoped that the generous example of Mr. Wilde will stimulate others of our wealthy members to rival his gift by valuable donations to the Building Fund.

Finally, I would speak of the growth of the Institution itself. From a total membership of 110 in 1872 we have increased to a total of 3254 at midsummer, 1899, and the statistics show clearly that the rate of increase is itself increasing. In the establishment of the new class of Associate Member we think we have secured a new element of strength. With the growth of total membership has come a new movement for the grouping of our provincial members in local branches. The Council has appointed a committee to organise these; and already preparations are on foot for constituting two local centres in the North, and another in Ireland; while our South African members, who have already constituted themselves informally into a local branch, holding meetings in Cape Town, which will shortly be officially recognised under our new Articles of Association. All these are signs of active progress. The novel departure made last summer, when the Council sanctioned the suggestion of an official visit to Switzerland, has already borne fruit in many ways. The Swiss tour brought together many of those who, though active members of the profession, cannot often attend the ordinary meetings in London. It not only enabled us to see what Swiss engineers are doing, it brought us into the most pleasant personal touch with our able and courteous Swiss *confrères*, and it procured for us an invitation to pay a similar visit to Germany at a date in the near future. But, best of all, it has, I think, enabled some of us to realise more fully than we did before the value of our connection with our own Institution of Electrical Engineers; it has taught us what the power and usefulness of our Institution may be; and it has knit us together and inspired us to do what we can to promote its prosperity and the prosperity of the great industry which it represents. In this spirit, and with the note of progress sounding in our ears, let us carry on the work of the session now opened.

THE annual dinner of the Institution was held at the Hotel Cecil on Wednesday, the 6th inst., and was attended by upwards of 250 gentlemen. The President, Professor Sylvanus P. Thompson, D. Sc., F.R.S., occupied the chair, and there were also present Lord Kelvin, Sir Courtenay Boyle, Sir J. Durston, K.C.B, Sir W. C. Roberts-Austen, K.C.B., Sir James Sivewright, K.C.M.G.; Sir Douglas Fox, President Inst. C.E.; Sir Philip Magnus, Sir H. Mance, the Hon. Justice H. H. Cozens-Hardy, General Sir R. Harrison, K.C.B., Inspector-general of Fortifications; Sir W. H. Preece, K.C.B., Sir G. Murray, K.C.B., Sir Henry Roscoe, F.R.S., Sir J. Crichton-Browne, F.R.S.; Mr. C. Hawkaley, Vice-president Inst. C.E.; Professors G. Carey Foster, R. T. Glazebrook, Ray Lancaster, and Perry.

After the customary loyal toasts, that of the "Navy, Army, and Auxiliary Forces" was proposed by Mr. R. E. Crompton, and was responded to by General Sir Richard Harrison, who spoke in high terms of the performances of the Navy in connection with the war in South Africa. The Navy, he said, had transported the whole of the troops to South Africa with regularity and precision. They had also sent the finest of men to the front, farther, he believed, from the sea coast than had ever been known in the case of men of the Navy before in time of war. The Boers were an enemy not to be despised. They had for years been preparing for this war, that they knew they intended to bring about. They had provided themselves with the very best of guns, and their organisation was certainly far better than anything we anticipated, and the numbers that they had put into the field were more than anyone in this country had been led to expect. He believed that the deeds of our arms would do more than anything else to induce respect for the British race in South Africa, and to cement the races who, he was sure, would ultimately work amicably together under the best and freest of Governments—the British Government.

The toast "Science" was proposed appropriately by Lord Kelvin, who said that pure science was indebted to the practical engineers, and that the latter had made good use of mathematics. When the electric telegraph came into practical existence in 1837, when ten years or so later they had their first submarine cables connecting England and the Continent of Europe, and when another ten years or so saw the first Atlantic cable laid, electrical science in all the Universities of Europe was in a very backward state compared to the position in which they saw it now. A very great stimulus was given to its study from its application to electric telegraphs, and especially to the great system of electric measurements which was so valuable now in pure science—a system which originated certainly not among practical engineers, but among University professors. Gauss and Weber gave them from Germany the foundation of the system of electric measurements of which they now enjoyed the benefits, and of which the first practical use was made in connection with submarine cables. He found a most excellent spirit prevailed now all over the world in relation to science. It was very different indeed compared to what it was fifty years ago. He remembered when the education of the young engineer consisted in paying a fee and being present for two, three, or four hours in an engineer's office, doing what he liked, playing pranks generally, and copying a drawing occasionally. Their scientific training ended about there. They made good engineers, nevertheless, but it was not through the teaching they got from engineers or from Universities. Now excellent work was being done in the teaching of science in the special direction of practical applications and in improving the profession of engineering and the engineering arts in their application to science.

The toast was responded to by Sir W. Roberts-Austen and Sir Henry Roscoe, both of whom had something to say *apropos* of the progress made in their respective branches of science. The former speaker said that if the century which was now so rapidly drawing to a close had been called the age of steel, it was none the less the age of electricity. The metallurgists had given the world the steel bridge, the armour plate, the armour-piercing shot, and the copper of good quality which conducted electricity so well,

but the electrical engineers had not only profoundly modified all the great industries of the country, but had also exercised a beneficent sway over almost every relation of human life. If they viewed science in its international relations they would see that there was no question of division, but that science united all peoples. No body of scientific men had done more to unite the relations of the world than the electrical engineers. The web of copper strands by which they had connected continents were far more enduring bonds than steel ties could ever be. For instance, the nation which lay closest to them—France.

The toast "Engineering" was given by Sir Douglas Fox, and Sir William H. White responded. The toast "The Institution of Electrical Engineers" was given by the Hon. Justice H. H. Cozens-Hardy, who compared electricians with the navigators of the fifteenth and sixteenth centuries. In replying, the President called attention to the new departure which is about to be made by the Institution in forming local sections in the provinces and the Colonies, to enable groups of members to hold meetings under the auspices of the Institution. Already such a local section has been in existence, informally, and has done good work in Cape Town, and it is expected that it will very shortly receive official recognition by the Council. Other local sections will probably be formed in January. He also alluded to the proffered donation by Mr. H. Wilde, of Manchester, of £1500 to form the nucleus of a benefit fund. Mr. Wilde's early work in the field of electrical engineering was in connection with the search-light and separately-excited dynamo, and he had also anticipated the mathematical deductions of the synchronising property of alternators. The membership list of the Institution now included 3300 names, and that within the next three or four years they hoped to find a suitable site for the erection of their own building.

Professor Perry proposed the toast of "The Guests" in his own humorous manner, and the reply, in the absence of Lord Welby, chairman of the London County Council, and the Hon. Justice J. C. Bigham, was entrusted to Sir Courtenay Boyle, who alluded to the growth of electric traction, there being 112 projects deposited at the Board of Trade office. In replying to Professor Perry's suggestion that the Government departments should more frequently call in the assistance of electricians, the speaker alluded to the differences which exist between the electrical engineers and the scientists with regard to electrical traction problems.

AUSTRALIAN NOTES.

(From our own Correspondent.)

I HAVE to record the death of Mr. P. B. Elwell, M. Inst. C.E., M.I E.E., which took place at Sydney on September 10th. Mr. Elwell, who was formerly connected with the well-known electrical firm of Elwell and Parker, held the position of electrical engineer for the New South Wales railways and tramways for the past eight years. Right up to the time of his death Mr. Elwell was engaged on the conversion of the existing steam tramways throughout the suburbs of Sydney to electrical traction, a large undertaking, on which good progress had been made. His position in the railway department is being temporarily filled by his former chief assistant, Mr. O. W. Brain.

The shareholders of the Adelaide and Suburban Tramway Company have accepted the offer of Mr. F. H. Snow, for the purchase of the company's rights and plant for the sum of £213,500.

During the past year the Victorian railways have spent £137,931 on new rolling stock, £126,028 on permanent way, buildings, &c. £55,255 on re-grading, and £26,682 on lighting, out of loan votes.

From an advance copy of the New South Wales Government Statistician's "Seven Colonies of Australasia," the following figures are given:—

Mineral Production, 1898.

Colony.	Gold.	Silver & silv'r-lead	Copper.	Tin.	Coal.	Other minerals.	Total.
	£	£	£	£	£	£	£
New South Wales ..	1,244,330	1,704,055	272 686	45,638	1,271,832	256,387	4,794,928
Victoria..	3,349,028	9,455	—	3,913	103,099	1,277	3,466,772
Queensland	2.750,349	10,585	2.166	86,502	150,493	12,616	2,962,711
South Australia	95,143	950	248,857	120	—	4,366	349,436
West Australia	3,990,698	—	4,266	2,760	1 625	38	3,999,382
Tasmania	281,485	270,893	382,640	115,762	19 454	—	1,070,234
New Zealand	1,080,691	33,107	70	—	458,517	5,509	1,572,894
Australasia	12,791,724	2,023,045	910,685	204,695	2,000 020	280,188	18,216,357

New South Wales overshadows all the other colonies in the production of coal; up to the end of 1898 the value of the total coal production being £34,321,205, the next best being New Zealand, with a production to the value of £6,611,998. South Australia holds the premier position in the output of copper, the value raised to the end of 1898 being £21,529,746 out of a total of £29,244,961 for the seven colonies. Although for the past year West Australia is leading in the gold production, it has a long lead to take up before it reaches Victoria—the total production to date being: West Australia, £10,659,716; Victoria, £250,738,820. But, as West Australia has been found to be such a gold-producing country where explored, it augurs well for its future prosperity, considering the immense track of country yet to be gone over, its area being 975,320 square miles, as against Victoria's 87,884 square miles.

The Minister for Mines has had a statement prepared showing the progress of the mining industry in New South Wales for the quarter ending September 30th last. The figures are as follows:—

Gold, 143,423 oz.	value	£500,662
Silver, ingots and matte, 256,701 oz.	,,	£26,631
Silver, lead, and ores, 125,567 tons	,,	£542,156
Copper, ingot, matte and ores, 1902 tons	,,	£129,582
Tin, ingots and ore, 300 tons	,,	£40,741
Coal, exported to foreign and intercolonial ports, 715,525 tons	,,	£256,378

Total value £1,496,150, showing a net increase of £330,862 over the previous quarter of this year. The total value of minerals for the nine months is now £3,846,691, or £776,425 in excess of that for the corresponding period of 1898.

As to Queensland railways, the Commissioner's report shows that new lines aggregating 109·81 miles have been opened for traffic during the year ending June 30th last, increasing the capital on opened lines from £18,056,285 on June 30th, 1898, to £18,670,208. Net revenue has been increased by £58,919, notwithstanding the abnormal expenditure which has been incurred for the purpose of improving the condition of the rolling stock. A remarkable increase in passengers has occurred during the year, being almost 1,000,000 in advance of the previous year, as follows:—

	1897-8.	1898 9.	Increase
Passenger journeys, exclusive of season-ticket holders, No.	2,742,108	3,716,425	974,317
Passenger revenue .. .. £	266,274	307,255	40,981

Traffic in agricultural produce has increased 52,079 tons over the previous year, while the revenue has only increased by £2157. This is due to the fact that the traffic in sugar cane, which as a rule is only carried very short distances, and at very low rates, has considerably increased. During the past three years a sum of £82,516 has been expended in the improvements of grades and curves, to allow of heavier loads being taken, and to reduce cost of maintenance. The report of the Board appointed to inquire into the two locomotive boiler explosions which took place in the Roma-street yards in August and December, 1898, has forced upon the Commissioner the desirability of reorganising the locomotive branch. With that end in view Mr. W. H Nisbet has been appointed Chief Mechanical Engineer, while Mr. H. Hornblow has accepted the position of deputy.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Sewage reservoir.—The sewage of the city of Boston is discharged into the lower part of the harbour, but is held in a great reservoir on one of the islands until ebb tide. Owing to the increase of the amount of sewage to be provided for, the reservoir is now being enlarged, and made double the capacity. The new section is 288ft. long on the west side and 475ft. on the east, with a width of 594ft. This area divided into four compartments about 148ft. wide, and 17ft. 6in. deep, as in the old reservoir. The storage capacity is increased from 50,000,000 to 100,000,000 gallons per day. The end wall of the old reservoir was torn down on the completion of the new work, making the old and new work one complete structure with four compartments 576 to 950ft. in length. The bottom is of concrete, made in two layers, each composed of one part cement, two parts sand, and five parts broken stone and gravel of ¼in. to 2½in. in size. The lower layer is 4in. thick, made with natural cement; the upper layer is 5in. thick, and made with Portland cement. The walls are of rubble masonry laid in concrete and capped with granite. Grooved and tongued sheet piling is driven under the middle of the division walls. The outer walls are backed with broken stone filling, and have earth embankments supporting them, the slopes being pitched where subjected to the wash of the waves. An oval flushing sewer 3½ft. wide and 6ft. high is carried through the end wall, and connects with four flushing chambers, one for each basin or compartment. These chambers are 15ft. by 17ft. Openings 2ft. wide lead into the basins. The basins have the bottom made nearly level in cross section, and with a fall of 12in. in the length, while the flushing sewer has a fall of 1 in 300, the rush of the sewage thus scouring and flushing the sludge which has collected during the period of storage. The flushing gates and discharge gates are operated by machinery.

A new typesetting machine.—Typesetting by machinery is now a well-established process, and the majority of the machines now in use are of the linotype pattern. One of the latest machines introduced into commercial service is the Lanston monotype machine, in which each letter or space is cast separately, instead of each line being one solid casting, as in the linotype. The Lanston machine is in two separate and independent parts, which are operated quite independently of each other. The first part is the keyboard, which resembles a large typewriting machine, the bank of keys comprising all the characters in the fount of type used, and three sizes of space type. The operator strikes the letter and space keys as required to form the words and sentences of the copy, as in typewriting, or as in the linotype machine. A travelling ribbon of paper is fitted at the back of the keyboard, and as each key is struck it punches two holes in the paper, one registering the horizontal line and the other the vertical line of which the key forms the intersection. A scale in front of the operator shows how the line is being filled. This ribbon of paper forms the "copy" for the casting machine, which has a case of matrices or moulds of letters corresponding in position to the letters on the keyboard. As the paper ribbon travels along, it causes the matrix case to move until each letter or space is in turn brought directly over the casting mould, over which it is accurately centred. As it comes into position, it is depressed to form a tight joint, and a jet of molten type metal is forced into the mould, filling it and the matrix, so as to form the body and the face of the type. When the jet is stopped, and the surplus metal trimmed off, the finished types are mechanically delivered to the galley. There is no distribution of types or matrices, though the type can be distributed like hand type, if desired. These machines are already in use for newspaper work.

Large tank locomotives.—Tank locomotives are comparatively little used in the United States, and those that are used almost invariably have the tank behind the cab side tanks not being used. The Schenectady Locomotive Works has recently built for the Dominion Coal Company, of Nova Scotia, two powerful tank engines with both side and rear tanks, the former being set considerably above the wheels, while the latter is set lower down over the trailing bogie. The cab is quite high up. One engine has six and the other eight coupled wheels, and both have a two-wheeled leading bogie and a four-wheeled trailing bogie. The dimensions of the eight-coupled engine are as follows:—

Cylinders	22in. by 28in.
Driving wheels	4ft. 7in.
Bogie wheels—leading, 2ft. 6in.; trailing ..	2ft. 4in.
Driving wheel base	15ft.
Total wheel base	36ft. 8in.
Boiler, diameter	6ft.
Fire-box, radial stayed	9½ft. by 3½ft.
Tubes, iron; No. 348; diameter	2in.
Tubes, length	13ft. 10in.
Heating surface, tubes	2513 square feet
,, fire-box	177 ,,
,, total	2690 ,,
Grate area	33½ ,,
Working steam pressure	200 lb.
Weight	107 gross tons
Weight on driving wheels	76 ,,
Water in tanks	400 imp. gallons
Coal in bunker	5 gross tons
Steam ports	18in. by 1¼in.
Exhaust ports	18in. by 2¾in.
Slide valves, balanced; travel	5¼in.
Top of valves, inside, ⅜in; outside	⅜in.
Lead of valves	1/16in.
Driving wheel journals	9in. by 10in.
Coupled wheel journals	8½in. by 10in.
Main crank-pin journals	7in. by 6½in.
Thickness of boiler plates	7/16in. to 11/16in.
Thickness of fire-box plates	7/16in. to ½in.
Blast pipe nozzles	5¼in., 5½in., and 5¾in.
Funnel, diameter	16in.
Funnel, height of top above rail	14ft. 9in.

Telephone cable tunnel.—A telephone company in Chicago is adopting a new system for its cables, and is building a tunnel, instead of laying conduits. This tunnel is 4ft. wide and 7ft. high, 30ft. below the surface, and great care is being taken to prevent any disturbance of the foundations of the tall buildings near which it passes. Being at such a depth, the tunnel will not be liable to interference by work on the sewers, gas mains, or water mains. Two of the shafts have been sunk and lined with brick, and work is progressing on the tunnel, which will be lined with concrete. The wires will be laid on rocks, and will pass up shafts or manholes in the alleys at the backs of the buildings. When the main tunnels are completed, which is required to be done within four months, the laterals and connections will be built, and the wiring system carried into all the important buildings, as the company is an independent concern, about to enter into competition with the existing companies.

Gas-producing and engine plant.—At the New York terminus of the Erie Railroad a gas-producing plant has been installed to supply fuel for seven gas engines, as follows: One of 90-horse power, driving an incandescent light dynamo for 1120 incandescent amps; one of 90-horse power driving an arc-light dynamo for 450 lamps of 2000-candle power; two of 45-horse power to drive a coal conveyor for the producers; air compressor; two Pintsch gas compressors; the automatic feeding apparatus of the producers and the pump which circulates salt water through the cylinder jackets of the gas engines; one 36-horse power engine to drive the coal-handling machinery of the locomotive supply yard; one 19-horse power engine to drive the ash-handling plant, and one of 19-horse power to drive tools in the machine shop. Until recently the engines have been worked by illuminating gas taken from the city mains, and the cost of this fuel for running two 45-horse power engines, and one 90-horse power engine was £3 7s. 6d. per day. With the gas from the producer plant the cost is but 5s. 10 per day. It has been found by tests that power from producer gas used direct in gas engines costs but half as much per delivered horse-power, as power from a good steam engine and boiler, while the first cost of plant is about the same. The producer plant has a capacity of 500-horse power, and develops about 12,102 B.T.U. per pound of buckwheat coal, and 1 indicated horse-power on 1·30 lb. of coal per hour. The 90-horse power engines have two cylinders, and can develop considerably more than their rated capacity. Tests made on one of the cylinders showed 49 to 55½-horse power, with an average of 52-horse power, so that the actual power of the engine is about 104-horse power. The consumption of gas was 92½ cubic feet per horse-power per hour, and the producer generated 21,832 cubic feet of gas per hour. The gas is carried a distance of 1200ft. in an 8in. pipe. The analysis of the gas shows 53 per cent. nitrogen, 19 per cent. carbonic oxide, 16 per cent. hydrogen, 3 per cent. marsh gas, 1 per cent. oxygen, and 8 per cent. carbonic acid.

Pulverising mill.—The Kent mill is one specially designed for pulverising hard substances, and is practically free from vibration and noise when working. A free revolving ring is supported by three inside crushing rolls in yielding bearings, so that the ring is cushioned and is free to run with the driven roll and to yield or move in all directions, according to variations of the strains. Thus it adapts itself to the conditions, and preserves an equable pressure at the rolls, while yielding to permit iron bolts or other ungrindable foreign matter to pass through. The ring and charge are revolved together within the mill, the charge being held against the ring by centrifugal force, so that for each revolution it passes under three rolls. As the ground particles become smaller they separate from the body of the charge, and fall into the discharge passage. The ring and rolls revolve on horizontal axes, and the material is fed in above from a hopper. Adjusting screws on the rollers enable the crushing pressure to be varied from zero to 20,000 lb. It can be used as a wet mill by feeding a stream of water with the material, and it will even pulverise moist and damp material. It can also be used as a granulator for concentrating purposes, as it can be adjusted to grind from 8 to 250 mesh. The wearing parts are of hardened steel, all the rolls are interchangeable, and all bearings are outside, babbitted, automatically oiled, and fitted with dust covers and water jackets. It is intended for such materials as ores, quartz, gypsum, cement, phosphate rock, coke, carbide, foundry facings, &c. A 20-horse power mill, which has been at work regularly twenty hours a day for four months, has ground 45 tons of phosphate rock in ten hours, and 12,180 lb. in one hour, to a sixty-mesh screen. The driven roll is operated by a belt wheel, the speed required being 180 to 200 revolutions per minute for the driving pulley.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE marked bar firms on 'Change, Birmingham, this—Thursday—afternoon readily obtained their late advance of £10 10s. as the minimum, and many of the unmarked bar makers quoted 5s. to 10s. per ton advance over last week's rates, declaring that, while they are so much behindhand with orders, the material for prompt supplies is fully worth the advance asked. £9 15s. to £10 was quoted by the strongest of the unmarked bar firms, though others would accept £9 10s. to £9 15s. The last advance of 10s. per ton in hoops and thin strip was confirmed, as was also the advance of 5s. to 7s. 6d. in common strip iron. Hoops are quoted £10 10s., and gas tube strip £9 5s. to £9 15s. per ton. Nail rod and rivet iron was £9 15s. to £10.

William Barrow and Sons declared their new prices for marked bar iron as: ordinary bars, £10 10s.; best, £12; and best best, £13; scrap bars, £12 to £13; and plating bars, £11 to £13. Angles are £11 to £12 10s., and £13 10s., according to quality, and hoops are £11 to £12 10s. B.B.H. plates and sheets to 20 w.g. are £11 10s.; best boiler plates, £12 10s.; treble best, £14 10s.; and extra treble best, £17.

John Bagnall and Sons, Limited, one of the leading firms in the marked bar iron trade, quoted their new prices this afternoon arising out of the recent advances of 10s. per ton in this class of iron, at: Flat bars, 1in. to 6in., £10 10s.; 6¼in. to 9in., £11; and large round bars of 5¼in., £13 10s. to £14. The firm's turning and horseshoe bars are £10 10s.; best rivet iron, £12; best best rivet iron, £13; and angle bars to eight united inches, £11. Hoops, from 14 to 19 w.g., the firm quote £11. Boiler plates to 5 cwt. are: Crown B. Bagnall, £12; best, £13; best best, £14; and best best best, £15 per ton.

The sheet iron trade was well sustained by increasing orders from the galvanisers, and some makers quoted 5s. to 7s. 6d. per ton more than a week ago. Sheets of 20 w.g. were £10 10s. to £10 15s., and 24 w.g. £10 15s. to £10 17s. 6d. Galvanised corrugated sheets were £15 f.o.b.

Pig iron held its own in spite of disappointing reports from Glasgow, and it is a reassuring circumstance that prices of both forge and foundry material are nearly 40 per cent. higher than at the commencement of the year. Best hot-air all-mine forge pigs range from 85s. to 90s.; foundry, 90s. to 100s.; part-mine, 75s. to 85s.; and common cinder, 69s. to 70s. for forge, and 72s. 6d. to 75s. for foundry.

A conference between the employers and employed in the light chain trade of the Dudley and East Worcestershire district has just been held to consider the wages question. Over twenty employers were represented. It was claimed on behalf of the men that, in consequence of the prosperous state of trade and increased prices of fuel, they were entitled to another advance in wages. Ultimately the employers decided to concede an advance of 10 per cent., and suggested a date when it should come into force. The representatives of the men promised to lay the proposal before them. The increase will affect every section of the chain trade, with the exception of the cable and hammered.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Whatever the causes that are contributing to bring about the result—whether dearer money, the South African war, or the not unusual indisposition to operate at all largely towards the close of the year—the position, so far as business in the open market is concerned, has during the last two or three weeks shown a gradual weakening tendency. Whether this unsatisfactory situation, which, as I previously pointed out is certainly not warranted by any indications of approaching slackening in the principal iron-using industries—the reports I receive from all the leading branches of the engineering trade still showing activity to be well maintained, with new work, if not quite so pressing, still coming forward in sufficient quantity to keep establishments fully engaged—is only temporary, is a question to which it is difficult to give a decided answer. Makers and manufacturers of iron are

confident as to the future, but amongst many of the merchants and dealers there is certainly a strong opinion that the maximum point has been reached. The result is that the position of makers and manufacturers continues altogether at variance with the course of business in the open market. On the one hand, makers and manufacturers are heavily sold, and being, as a consequence, indifferent about booking new orders, are holding firmly to their full rates. On the other hand, merchants and dealers are freely underselling, and, as many of them are large holders of iron bought at considerably below current rates, they are able to cut in at figures far under what makers would in any way entertain.

The effect of this abnormal condition is necessarily reflected on the market, business of any moment being for the present held in check. One or two fair inquiries for pig iron are reported, but for the most part the buying going on is only in small quantities. For foundry qualities Lancashire makers are firm at last week's full quotations; Lincolnshire makers are still quoting 1s. above their basis rates, and report occasional sales at about 76s. to 76s. 6d. net, delivered Manchester. The low sellers of Derbyshire referred to a week or so back would now seem to have filled up their books, and are holding more firmly to previous quotations, 78s. 6d. to 80s. net being again asked, delivered here. Merchants, however, are sellers of both Lincolnshire and Derbyshire at, in some cases, 1s. to 1s. 6d. under makers' quotations. Forge qualities are generally scarcer, and in these there is practically little or no underselling; Lincolnshire makers are getting about 75s. 2d. net, with Lancashire makers quoting about 77s., less 2½, delivered Warrington. Both Middlesbrough and Scotch brands are easier. Middlesbrough makers are still asking 78s. 4d. to 79s. 4d. for No. 3 foundry net, delivered by rail Manchester, but merchants are sellers as low as 76s. 4d. to 76s. 10d. Scotch makers during the past week have been meeting the market, and quoting delivered Manchester docks, about 81s. 6d. net for both Eglinton and Glengarnock.

The recent advance in finished iron has put rather a check on further buying, but as makers are quite indifferent about booking new orders, they are not at all affected by any lessened quantity of business just now coming forward. For Lancashire bars they are firm at £9 10s. as the minimum; North Staffordshire bars, although there is not as yet any official advance, are not quoted under £9 15s. to £10, with sheets and hoops strong at late rates.

The position of the steel trade remains practically unchanged. For hematites makers still quote 90s. 6d. to 93s., less 2½, with warrants many shillings below these figures. Steel billets are firm at £7 10s. net; bars range from £9 to £9 15s., according to quality; tank plates, £9 2s. 6d. to £9 5s.; and boiler plates quoted £9 10s. up to £9 15s., but sales have been put through during the past week at as low as £9 5s. for prompt delivery, where makers have been temporarily short of specifications.

The monthly returns of the trade union organisations connected with the engineering industries show a further reduction of the unemployed list. The Steam Engine Makers' Society has now only about ¾ per cent. of the total membership on donation, whilst in this immediate district there are practically no members receiving support. In the United Machine Workers' Association the proportion has fallen to just over 1½ per cent. of the total list, whilst the general average in the Lancashire branches is about one per cent., some of them reporting a clear book. Returns from the various centres as to the state of trade also continue of a favourable character.

Recently numerous reports have been circulated respecting large American inquiries coming into this country for various descriptions of raw and finished material, both in iron and steel, and during the past week an inquiry has been going the rounds of the market here for 20,000 tons of steel tank plates required for the United States. Apparently, however, there is a good deal of exaggeration as to the amount of business really put through. The representative of one large firm that does a considerable American trade informed me on 'Change that their inquiries alone would probably amount to upwards of 100,000 tons, for hematites and raw material generally, but they could not trace more than about 10,000 to 11,000 tons of actual business put through altogether in this country for America, and although large inquiries were sent over here, these represented only a very limited proportion of actual business.

The whole of the work connected with the important electric power and light installation that is being put down by the Salford Corporation, at a cost of about £400,000, has been placed with firms in the Manchester district. The contract for the boilers has been secured by Galloways, Limited; that for the engines by Browett, Lindley, and Co., Limited; and the order for the electrical plant by Mather and Platt, Limited.

The requirements of the Government, apart altogether from war materials in connection with the transport of troops to South Africa, have brought exceptional pressure on many branches of industry, and I may mention as an illustration that A. C. Wells and Co., have been entirely cleared out of their stock of portable lights, which were required to facilitate shipment and transhipment arrangements, and further large orders have been received for despatch to South Africa, whilst electrical engineers have been pressed for work in connection with the fitting up of the various transports.

At the annual meeting of the Manchester Association of Engineers, held on Saturday, Mr. Henry Hodgson, of Scott and Hodgson, Guide Bridge, was elected president for the ensuing year, and the other offices were filled up as follows:—Treasurer, Mr. James Walthew; trustees, Sir W. H. Bailey, Messrs. G. Carter, T. Ashbury, J. West, and S. Dixon; members of Committee of Management, Messrs. J. Saxon, W. Smith, and Hardman; auditors, Messrs. T. Daniels and G. Daniels; secretary, Mr. F. Hazelton; librarian, Mr. R. Gass. Twenty-four new members were also elected, and the retiring president, Mr. Henry Webb, to whom a hearty vote of thanks was accorded for his services in the chair during the past two years, announced that the total membership was now 467.

In the coal trade the position is becoming decidedly stronger. With the complete change in the weather during the past week there is necessarily a larger inquiry for house-fire qualities, whilst the pressure of demand for all other descriptions of fuel is fully maintained, and a shortness of supplies to meet present requirements is the general report. Following upon this exceptional state of the market is the further advance in wages that has been conceded to the miners, and under such conditions it is scarcely surprising that a further upward move in prices with the close of the month is not only being talked of, but would seem to be much more than probable.

For the better qualities of round coal there has been a generally active inquiry during the past week, which has been more than sufficient to take away all that collieries are raising, and this has lessened the quantity of the lower-class round coals for steam and forge purposes, which is causing rather a shortness of supplies, and prices have been hardening, 10s. 6d. being about the average figure for ordinary descriptions at the pit, 6d. or so above this being obtainable from outside buyers anxious to obtain supplies. Notwithstanding the increased production of slack consequent upon the large quantity of round coal now being screened for house-fire purposes, supplies of engine fuel do not appear to be any more plentiful, at any rate in the open market. Most collieries still find it difficult to meet even the requirements of their regular customers, and outside buyers have to pay special rates. List rates at the pit remain at about 9s. to 9s. 6d. for best sorts; 8s. to 8s. 6d. for medium; and 7s. to 7s. 6d. common slack; but these really only apply to sales to regular customers or renewals of current contracts.

In the shipping trade not more than a moderate business is just now coming forward, but there are some fairly large inquiries in the market for supplies before the close of the month, and prices show an upward tendency, ordinary qualities of steam coal fetching about 12s. up to 12s. 6d., delivered ports on Mersey or Manchester Ship Canal.

Coke is without actually quoted change, but makers are compelled to decline a good deal of the business offering, and are all hardening up in their prices pending some official advance, which will certainly come into operation before the close of the month.

At a meeting of the Manchester Geological Society on Tuesday, Mr. Joseph Dickinson, F.G.S, introduced a further improved form of Howat's safety lamp for use in mines, of which we have previously given a short description. The latest type of the lamp has been designed to burn paraffin oil, and to prevent the tendency of the oil—by reason of the heat of the lamp—to rapidly vaporise, and pass up into the flame chamber in excessive quantities, causing the light to smoke, or be extinguished by internal explosions. The flame chamber is isolated from the oil reservoir, whereby an air space is formed, and air allowed to circulate in such space, and there is a much longer wick tube, so that the lamp, it is claimed, will burn paraffin with absolute safety. A milled disc is provided for raising or lowering the wick, and there is a small tube opening into the interior of the oil cup and to the atmosphere, constituting a vent for any vaporised oil. The illuminating power of the lamp has been tested at the Gaythorn-street Gasworks, Manchester, and taking the standard Marsant as the unit, Howat's lamp gave 1·85.

Barrow.—The hematite pig iron trade is very brisk, and business is plentiful, but makers are so fully supplied with orders that they are not in a position to quote for either prompt or forward deliveries. They are quoting mixed Bessemer Nos. at 77s. 6d. to 80s. per ton, and are not following the downward current of warrant prices, which are actuated by some influences at variance with the law of supply and demand. The fact that the demand is greater than the supply is sufficient to make warrant iron a much more marketable commodity, and in ordinary circumstances this would be the case, but other than ordinary reasons have led to the reduction in prices to 74s. 7½d. net cash sellers, 74s. 6½d. buyers. The stocks of warrants, which have been on the decrease for a few weeks past, have this week been increased by 1742 tons, and now stand at 210,786 tons, or 34,807 tons increase since the beginning of the year. There are forty-seven furnaces in blast, as compared with forty in the corresponding week of last year.

Iron ore is in fuller request than ever, and as foreign sorts have increased in price to 20s. and 21s. per ton delivered, native sorts are now at 16s. for good ordinary qualities. The rush is for early deliveries, as smelters are in want of supplies, but these cannot readily be obtained.

The steel trade is exceedingly busy, and orders are very fully held all round. This is particularly the fact as regards heavy rails and shipbuilding material, and the demand in both these branches is very active. Orders are very fully held for all classes of steel, and prices are very well maintained. Heavy rails are still at £7 and ship plates at £8 per ton.

Shipbuilders and marine engineers are very busy indeed, and are not at present increasing their responsibilities.

Coal and coke are in full demand, and at very firm prices, which show a disposition to advance.

Shipping is exceptionally busy. The exports of pig iron last week from West Coast ports were 23,331 tons, and of steel 12,849 tons, showing an increase on the corresponding period of last year of 18,431 tons of pig iron and 5289 tons of steel. The aggregate shipments for the year have reached 513,287 tons of pig iron and 468,779 tons of steel, showing an increase of 16,815 tons of pig iron and a decrease of 25,306 tons of steel as compared with the corresponding period of last year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

WE are now experiencing a sharp touch of winter, and the best testimony which can be afforded to the lack of coal locally is the fear—already verified this week in several quarters—that a further advance in price will be caused thereby. The long-continued mild weather staved this off, but there is little doubt that the large output having moved so readily and stocks being practically nil, the coalowners, if they pleased, can make the public pay more money, and the miners' agents are evidently in the same mind as the masters. The pits are now being worked very regularly, as the men are looking forward to the Christmas holidays, when, encouraged by the bright outlook in their industry, they will no doubt "play" longer than usual. The amicable settlement with regard to wages is exactly as was anticipated, and will have the effect of increasing confidence all round.

For London the requirements in house coal are steadily maintained, and it would not surprise us to find another advance imposed by merchants. Best Silkstones are now from 11s. 3d. to 12s. per ton; ordinary, from 10s. per ton; Barnsley house, 10s. 9d. to 11s. 3d. per ton; seconds from 10s. per ton; nuts, from 8s. 9d. to 9s. 6d. per ton. Although the season of the year is so advanced, steam coal seems to be more in request than ever. Such railway contracts as expire this month may now be taken as practically settled for the half-year commencing in January on the basis of 10s. per ton. This was the price which the railway companies refused to pay last half-year, and it is rather less than what the coalowners intended to stand out for, but it is no more than has been already secured by coalowners offering their output in the open market.

To the Humber ports an exceptionally heavy weight, considering the season of the year, continues to be sent, and the inland demand is above the average. Barnsley hards are 10s. 3d. to 11s. per ton; seconds, from 9s. 6d. per ton. Gas coal is in demand at full rates. For engine fuel and small coal for coking purposes values are again firmer, particularly in the latter qualities. Nuts fetch 7s. 9d. to 8s. 9d. per ton; screened slack, 6s. to 6s. 6d. per ton; pit slack, from 4s. 9d. per ton. In coke heavy weights are accepted for forward delivery from 18s. to 20s. per ton, but the general quotations now ruling are from 1s. to 1s. 6d. more.

The South Yorkshire coal trade, which includes part of Derbyshire, with the port of Hull, during November amounted to 293,792 tons, this being an increase of 15,776 tons on November of last year. For the eleven completed months of the year 3,248,169 tons were sent to the port, showing an increase this year of 105,328 tons. Exports to foreign countries, however, fell off during the month, the weight sent away last November having been 126,963 tons, or a decrease of 37,576 tons. For the eleven months 1,685,170 tons were forwarded, as compared with 1,579,357 tons in the eleven months of 1899. Although the increases quoted for the eleven months do not appear to be very large, it has to be borne in mind that the closure of the Welsh coalfield through the strike has swollen the trade of the great Yorkshire port last year to some 35 per cent. above its average.

There is little change to report in the condition of the iron, steel, and heavy trades generally. All-round activity is reported, particularly in armour plates, gun equipment, shot and shell. In these goods the various firms concerned are working night and day. In the lighter trades there is some expectation that, owing to the war and the large number of families placed in mourning, there may be a considerable falling off in sterling silver, best plated ware, cabinets and cases of cutlery, and other expensive wares prepared for gift purposes. Orders, however, for most of these goods were placed some time ago, and the effect of the war will not fall upon Sheffield in that respect just at present.

There is a very good continental trade going on now. This, of course, is counterbalanced through the paralysis caused by the war in the various South African markets. Several of our local firms, however, have been reminded by customers at the Cape that the close of the contest will be followed by an excessive rush for goods. These firms have put themselves in a position to meet the expected demand. The excellent business already reported for Canada is fully sustained, but the recent stiffness of feeling with regard to French attacks upon England is stated to have caused a rupture of the friendly relations which had followed the settlement of the Fashoda trouble.

NORTH OF ENGLAND.

(From our own Correspondent.)

BUSINESS in the pig iron market this week has been practically at a standstill, for traders would not operate in face of the violent fluctuations which have taken place on the warrant market, and certainly would not pay the prices that makers and merchants asked for what they had to sell. They have, as a matter of fact, kept their quotations up—the makers because they have little or no iron to sell, and the merchants because they consider the fall is not justified by the real condition of trade, and that it is solely a ring on the part of speculators, which must shortly collapse. Makers' prices are a good deal above those of warrants, and producers are undoubtedly very independent, as they are well supplied with contracts, and are under no necessity to press for more. When every industry that consumes pig iron is unprecedentedly busy, and has the best of prospects before it, there is no reason, they say, why the price of the raw material should decline. On Wednesday, when the price of Cleveland warrants went down to 64s. 9d. cash sellers, makers continued to ask 70s. per ton for their No. 3 Cleveland G.M.B. pig iron. They did not, of course, get it, but they would not sell at less, and merchants' quotation has not been below 68s., and then could only offer very small quantities, as the quantity of iron over which second hands have control is not large. Besides, they expect the prices of warrants to advance again, as they did a short time ago when the speculators unduly forced them down.

The reasons given for the unsatisfactory state of the warrant market this week were the news from South Africa, the drop in other metals, particularly copper and tin, and the great expense that will be incurred in carrying warrants over the winter, owing to the dearness of money. Some of the holders have, therefore, been pressing their warrants for sale while good profits were realisable, and so many offering has brought prices down quickly. Wednesday's price for Cleveland iron was 2s. 4d. below Monday's, 4s. below the figure rating at the commencement of the month, and 6s. 4½d. below the best price of last month, and 10s. 4½d. below the best price of the year, the last being realised towards the end of July. Many believe that if they hold their warrants till the spring they will find the prices as good as ever they have been this year, but some cannot afford to keep them over the quiet period of the year, and they are afraid they will have to accept less if they wait longer. Their selling, however, has demoralised the market during the last few days, and buyers of makers' iron have been conspicuous by their absence. It paid better to purchase warrants. Since Wednesday morning there has been some recovery in the warrant market, and the situation is not so unsatisfactory as it was during the early part of the week.

The market for the lower qualities of Cleveland pig iron is stronger than it is for No. 3, as it is not so much influenced by adverse movements in warrant prices. These lower qualities are not those in which a speculator operates, and none are sent into the public warrant stores, while only a comparatively small quantity is in the hands of merchants. The makers have this market pretty well in their own hands, and it is interesting to note that they are realising more for forge iron than is accepted by some sellers for No. 3, which is a rather anomalous state of affairs. For grey forge, 68s. 6d. has been paid this week. Yet only a few weeks ago No. 3 was 2s. 6d. to 3s. above No. 2, and now most consumers refuse to pay even 68s. for it, when they have been able to buy warrants at so much less. Forge iron is very scarce indeed at present, and some of our finished ironworks have been brought almost to a standstill, because adequate supplies have not come in from the pig iron makers from whom it was brought. It is expected, however, that more will be forthcoming after Christmas, as the furnaces work less satisfactorily during the holiday period, and a greater proportion of forge quality iron is produced. More especially will this be the case this year, as some of the furnaces will probably have to go on slack blast because of short supplies of coke.

Hematite pig iron is very scarce, and traders everywhere complain that the supply is below the demand. Makers quote 82s. 6d. per ton for mixed numbers, but that is practically a nominal figure. West Coast iron is much cheaper than this, and West Coast hematite warrants have been down at 72s. 4d. this week. For East Coast hematite warrants, however, 80s. 6d. has been offered, but none are procurable, for the 10,000 tons in Connal's stores are held by people who have confidence in the market, and expect to see better prices. They can afford to carry them. Under ordinary circumstances West Coast hematite iron is 2s. per ton dearer, but now the situation is not so good there as it is here, there being twenty times as much stock held in the public stores. Makers here are indifferent about selling, and so keep up their prices. Rubio ore has been advanced another 6d. per ton this week, merchants quoting 21s. per ton delivered at the wharves in the Middlesbrough district.

The scarcity in the supply of coke is very pronounced—indeed, it approaches a famine, and it is expected that during the Christmas and New Year's holidays the difficulties of consumers will be much increased, and that many of the furnaces will have to be put on slack blast, as there will not be coke enough to keep them fully going, though makers have been doing their best to get in a stock of coke to tide them over the holidays, and have paid extra high prices—27s. and over—and they have had to do so because, if they would not pay the price, the coke manufacturers had no difficulty in selling it to the West Coast consumers and those on the Continent, who are clamorous for supplies. The price for medium coke for next half-year's delivery varies from 24s. to 25s. at the Middlesbrough furaces, but it is reported that West Coast firms have bought Durham coke at 31s. delivered there—a price which would leave something like 25s. at the ovens, this being 2s. more than is regularly offered by Cleveland makers. Coke is now relatively dearer than pig iron, and must leave a considerable profit to the manufacturer. On this account every effort is made to increase the production of coke, but it is still much short of the demand, which from the Continent has never been so keen.

From the Cleveland district the pig iron exports this month are very satisfactory, quite exceeding expectations. They considerably exceed those of any previous December, and thus the characteristic feature of the year — unprecedented shipments — is maintained. This month, up to the 13th, they reached 43,966 tons, as compared with 39,820 tons last month, and 36,980 tons in December, 1898, to 13th. The stock of Cleveland pig iron in Connal's warrant stores has dropped to 73,771 tons, a decrease for the month of 673 tons. Of hematite pig iron 10,053 tons were held on 13th, a decrease for the month of 615 tons. It was expected that stocks would have increased, as they generally do in December.

All branches of the manufactured iron and steel industries, and also of the industries allied thereto, are unprecedentedly busy, and yet they do not by a long way satisfy the requirements of consumers, who do not seem to be at all deterred by the frequent advances in prices, but are rather stimulated to buy more freely, as they are of opinion that they will have to pay more if they wait. Most of the producers are considerably behind in the execution of their contracts, and naturally they do not regard the coming holidays with much favour, as they will be driven further behind. It is probable that the holidays will be more prolonged than usual because the men are well off. Common iron bars are quoted at £8 15s.; best bars at £9 5s.; iron and steel ship plates at £8; iron and steel ship angles at £7 15s.; steel boiler plates at £9 5s., all less 2½ per cent. f.o.t. Manufacturers of iron plates and angles are able to get fully the same prices as producers of steel, as the business is now confined to very few hands in this district. Heavy steel rails are at £7 net at works.

The coal trade has seldom or never been so brisk as it is at present, the activity being observable in every branch. Demand is far in excess of supply, and the latter cannot well be increased materially. From abroad the inquiries are very numerous, which is unusual at this time of the year; but it is reported that consumers on the Continent are very badly off for supplies, especially of steam and manufacturing coal, and local consumers are doing their best to get extra quantities for use during the holiday season. The bad weather at sea has delayed shipments, and this week the snowy weather has blocked up some of the wagon lines, so that it has been difficult to get the coal down to the staiths. As showing the scarcity of Durham coal, it is reported that one of the chief Tees-side manufacturing firms has bought coal from South Yorkshire. The North Bitchburn Coal Company early next year will commence the sinking of two pits in the Cockfield district in South-West Durham.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron warrant market has been very unsettled this week. In the early part of the week prices had an easier tendency, owing to the monetary situation. Speculators have been endeavouring to reduce their operations, wherever these involve the borrowing of money, and bankers are also being more stringent with reference to loans. This state of matters tends to restrict the business very materially in pig iron warrants. But in addition to this the market has shown itself very sensitive as regards the war news, and something like a panic occurred in the iron ring on Wednesday forenoon.

Scotch warrants fell nearly 2s. per ton. There was a partial recovery later the same day, when it was reported that General Buller had gained a great success in his operations for the relief of Ladysmith. Altogether the iron market is very disturbed. There is at present very little iron being bought for future delivery. Consumers have been paying such high rates that they are glad to see some relapse in the price of raw materials, and in view of the near approach of the holidays, they are inclined to keep out of the market as much as possible.

Business has been done in Scotch warrants from 68s. 4d. to 65s. 5½d. cash, and 68s. 6d. to 66s. 1d. one month. Cleveland iron has sold from 67s. 5d. to 64s. 9d. cash, and 67s. 9d. to 66s. one month, business also being done in this class of iron at 65s. 3d. for delivery in seven days. The transactions in Cumberland hematite warants have varied from 75s. 4d. to 72s. 1½d. cash, and 75s. 10d. to 72s. 9d. one month. From the lower of these rates, as has already been hinted, there has been some improvement, but the market continues very sensitive.

There are 83 furnaces in blast in Scotland, compared with 82 at this time last year; and of the total 44 are making hematite, 37 ordinary, and 5 basic iron.

The prices of Scotch makers' iron are as follows:—Govan, f.o.b. at Glasgow, No. 1, is quoted 70s.; No. 3, 69s.; Carnbroe and Wishaw, No. 1, 78s.; No. 3, 75s.; Clyde, No. 1, 83s.; No. 3, 79s.; Calder, No. 1, 83s. 6d.; No. 3, 79s.; Gartsherrie, No. 1, 84s.; No. 3, 79s.; Summerlee, No. 1, 84s.; No. 3, 80s.; Coltness, No. 1, 87s. 6d.; No. 3, 79s. 6d.; Glengarnock at Ardrossan, No. 1, 81s. 6d.; No. 3, 77s.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, Nos. 1, 79s.; Nos. 3, 76s. 6d.; Shotts at Leith, No. 1, 84s.; No. 3, 80s.; Carron at Grangemouth, No. 1, not quoted; No. 3, 81s. per ton.

The large consumption of pig iron at home has made it necessary to make further inroads upon stocks. The stock in Messrs. Connal and Co.'s Glasgow stores shows a reduction this week of about 3000 tons.

The finished iron and steel trades are busy in almost every department, and owing to the break away in pig iron, manufacturers are hopeful that they may obtain a little relief from the very heavy costs they have recently had to meet.

The coal trade is very active, and to the large demand formerly experienced, has this week been added a sudden increase in the household consumption owing to cold weather and a heavy fall of snow. The depth of the snowfall in some districts has interfered to a considerable extent with road traffic, although there does not seem to be as yet any very serious obstruction on the railways. The shipments of coals are almost equal to those of the preceding week, which showed a heavy return. The quantities being despatched are indeed remarkably large for the season of the year. There is now, however, comparatively little chartering going on of steamers for coal cargoes. At the same time coalmasters have as much work as they can possibly accomplish, and prices are very firm.

A great deal of surprise and not a little dissatisfaction has been occasioned by a decision arrived at this week by the principal Scottish railways to advance the rates of carriage for coal, coke, and minerals, on the *ad valorem* principle from 1d. upwards, the charge to commence on 1st January. It is represented on behalf of coalmasters that the railway companies did not require to make this advance owing to having to pay more money for their own fuel, and in support of this contention it is pointed out that the railway companies made their contracts for coal in the month of May last, when prices were much lower than they are just now, and that these contracts will keep them supplied until the end of May next year. Attention has also been called to the fact that the English railways, while paying more for fuel, carry coal at much smaller rates than the Scotch railways, and that the latter have not incurred very heavy expenditure in endeavouring to provide better facilities for the carriage of coal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

FULLEST vigour continues to characterise every branch of the coal trade. The seasonable weather setting in has given quite a spurt to house coal, and steam remains particularly firm, the only complaint being that it is so scarce. The output is steady, and in very few places, even in the west, is there any friction. In proof of the steady output I find that pitwood is becoming scarce, notwithstanding a good deal of wood from France, Spain, and some from Ireland. Norway wood generally goes to the North of England. The pitwood scarcity was shown last week by a temporary stoppage of the Gadlys Collieries, Aberdare. Other colliery owners tell me that they are hard pushed. It appears that a fog in the Bay of Biscay has had something to do with it by delaying pitwood vessels. So runs the report.

Coke, next to coal, is indicating remarkable vitality. The premier qualities, South Wales and Durham, which a short time ago only commanded from 16s. to 18s. at the ovens, now command 27s. Not only is there a large home demand, but the merits of the Welsh coke are being practically admitted by foreign buyers.

In the Newport district the coal trade is very brisk. Last week over 86,000 tons were shipped foreign and coastwise.

Latest Cardiff prices were as follows:—Best steam, 20s. to 21s.; seconds, 19s. to 19s. 6d.; drys, 18s. to 18s. 6d.; best Monmouthshire, 17s. 6d. to 18s.; seconds, 16s. 3d. to 16s. 6d.; best steam small, 11s. 6d. to 11s. 9d.; seconds, 10s. 6d. to 11s.; drys, 9s. to 9s. 6d.; best households, 16s. 6d. to 17s.; No. 3 Rhondda, 18s. 6d. to 19s.; brush, 14s. 6d. to 15s.; small, 12s. to 12s. 6d.; No. 2 Rhondda, 15s. 6d. to 16s.; through and through, 13s. to 13s. 6d.; small, 10s. 6d. to 11s. Patent fuel, 18s. to 20s. Coke furnace, 26s. to 28s.; foundry, 29s. to 30s.; special, 35s. Pitwood, 20s. ex ship.

Forest of Dean coal trade brisk and prices firm.

Last week the driving wheel of the fan at Pochin Colliery, Tredegar, broke, and caused two pits to be idle. The repairs will take a week or two, but the company has found employment for all the men.

The settlement amongst the Western Collieries, resulting in a levelling up of prices, has been attended with satisfactory results to the men, some receiving as much as a 25 per cent. advance.

Next week one of the rare events in coal annals, of mineral property being brought to the hammer, is to take place at Cwmbran, Newport, when property containing three valuable seams will be disposed of.

Latest coal prices, Swansea, are as follows:—Anthracite, 15s. to 16s.; seconds, 14s. to 15s.; ordinary large, 11s. 6d. to 12s. 6d.; small rubbly culm, 6s. 6d. to 7s.; steam, 19s. to 20s. 6d.; seconds, 17s. to 18s.; bunkers, 14s. 6d. to 15s. 6d.; small, 10s. to 11s.; delivered f.o.b. Swansea, cash thirty days. All house coals continue posted up, "subject to arrangement."

The Swansea Harbour Trust has decided to erect a large warehouse at the South Dock, and to increase the quayage at the same dock to the extent of another thousand feet. Estimated cost is £50,000. Speculative operations continue to give the pig iron trade a flatness and irregularity not justified by the state of business. Scotch left off last week lower by 2½d. per ton, Middlesbrough 1s., and hematite 5½d. In finished iron and steel tin-plate bars have been advanced 10s. Production on 'Change was reported short, and affecting the regular working of the mills. Block tin is lower, but tin-plate makers are quoting higher. Makers are well sold for some time to come, and buyers are fortunate in getting orders placed at present prices; other raw material very high. Latest prices all round were reported very firm. Pig iron: Glasgow warrants, 68s. to 67s. 11d. cash buyers; Middlesbrough No. 3, 67s.; other numbers in proportion. Welsh not reported. Middlesbrough equivalent reported 82s. 6d., and little obtainable. Last Welsh quotation, 82s. 6d. to 85s.

Hematite warrants, 75s. 2d. to 74s. 11½d. for mixed numbers, f.o.b. Cumberland, according to brand. Welsh bars, £9 to £9 10s.; angles, &c., at usual extras, f.o.t. at works; sheets, iron and steel, £10 5s. to £10 10s.; steel rails, heavy, £7 10s. to £7 15s.; light, £8 10s. to £9 10s.; sleepers, &c., according to section and specification; Bessemer steel, tin-plate bars, £7; Siemens, best, £7 2s. 6d.

Tin-plates: Bessemer steel cokes, 16s. to 16s. 3d.; Siemens, coke finish, 16s. 3d. to 16s. 6d.; ternes, per double box, 28 by 20 C., 29s. 6d.—30s. 6d. to 34s.; best charcoal, 16s. 6d. to 17s. 6d.; thick sheet for galvanising, 6ft. by 3ft. by 30 g., per ton, f.o.t., £14 15s. to £15; finished black plate, £12 15s. to £13; Canada, £10 10s. to £11 5s.; galvanised sheets, 24 g. £14 10s. to £14 15s. Block tin, £110 10s. to £111. Spelter, £20 10s. Copper: Chili bars, £72 5s. to £71. Lead, £17 10s. Iron ores: Tafna, 17s. 6d.; Rubio, 18s. 6d., all Swansea ex ship.

Welsh smelters are moving. A meeting this week of the Executive decided to renew the demand for a 20 per cent. advance throughout the Swansea district. The secretary of the Steel Makers' Association is expected to visit and take action.

Large quantities of pig iron have come in from Millom, Workington, and Harrington.

The outcome of the great pressure at the iron and steelworks and kindred industries is showing itself in large and variable despatches on the chief lines, and by shipment to foreign destinations. Within the last few days there were large clearances at Newport, 795 tons of rails and 1230 tons sleepers going to Madras and Calcutta, 450 tons rails to Faversham, and 60 tons to Highbridge; from Cardiff 900 tons galvanised iron to Monte Video, Buenos Ayres, &c.

In connection with the increased attention given to sheets, iron and steel, I note that there was a meeting of operatives last week at Newport, Mon., with the object of affiliating the society with that of the Midland Iron and Steel Wages Board. For some time the sheet-rolling industry has been on the increase, and a marked feature appears opening out, particularly in black sheets and galvanised iron.

All the steel-producing departments in the Swansea Valley are active. At the Upper Forest another stack is being erected to serve the new furnace which will soon receive gas. At Millbrook one furnace is brisk, and another will start shortly. Trade at the copper works is good; spelter working regularly.

I regret to record the death of Herr Franken, managing director of the Mannesmann Tube Works, Landore. He was an able commercial man, and much esteemed.

The tin-plate trade is satisfactory. Last week the shipments were 63,592 boxes; received from works 55,874 boxes. Present stocks, 150,838 boxes. The November shipments totalled 55 per cent. over November, 1898. Details are encouraging. Russia took 5170 tons as against 4467 tons; Denmark, 262 tons against 364; Germany, 2040 tons instead of 2283; Holland, 1183 tons in place of 620; Belgium, 1102 tons against 26; France, 1149 tons instead of 886; Portugal, 230 tons against 455; Italy, 964 tons instead of 846; Austria, 157 tons against 120; Straits Settlements, 378 tons to nil; China, 54 tons to nil; Japan, 514 tons to nil; United States, 4724 tons to 1490; total, 17,927 tons against 11,558 tons.

The large steel works on the hills are in full drive. Dowlais has been getting large quantities of spiegel and manganese from Middlesbrough; manganese ore from Poti has come in from Blaina and Pyle.

At Briton Ferry the output of hematite iron has been exceptionally large. Coke works very active. At Llanelly there has been a serious but happily not fatal pit flooding at Glanmwrog by driving into an old working.

The high Bank rate is telling adversely on stocks and shares. Coal and iron shares continue to be offered. Ebbw Vales have been exchanged for 11⅛ and 11, Rhymney iron new at 30s.; Albions have fallen ⅜, Ebbw Vales ⅛, Rhymney new 6d.

Trouble seems to be brewing amongst the railway men in Wales. On Sunday a mass meeting of the Taff Vale, Rhymney, Barry, and Cardiff railway men was held in Cardiff, when it was estimated that a thousand men were present. The chairman, Mr. Marsh, reviewed the condition. The demands of the men were for at least a week's work, limited to sixty hours, subject to the condition that the men will not be paid for time lost through holidays taken by colliers. Special provisions were also asked for in times of strikes, and it was also stipulated that all time worked between 6 p.m. and 6 a.m. shall be paid for at the rate of eight hours per day. Several speakers commented at length upon the effort that had been made to get a peaceful solution of the difficulty, and of the failure to obtain a meeting of the representatives with the directors; and finally, upon the motion of a speaker, it was moved and carried, with only three dissentients, that the delegates place the matter in the hands of the E.C., so that the rule laid down for the government of movements of the kind be put in force. The opinion is that the men are being prompted to take advantage of the prosperous times, and the busy night and day work on all lines, and that there is a strong probability of a strike in order to force concessions.

The cost of the coal strike has had the addition of another item, that for the military occupation. This was discussed at the Glamorgan Finance Committee County Council this week, and was given at close upon £5000.

The Llanelly Harbour Commissioners are to receive their new dredger in February. During November forty-six vessels paid dues. The import of iron and steel bars that month amounted to 2047 tons; exports, exclusive of tin-plates, 11,375 tons.

The Lundy Island and Mainland Quarries, Limited, has been announced. Capital £30,000. Mr. Richard Corry is one of the directors.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal keeps very firm for all descriptions, and inquiries for future shipments are satisfactory. House coal in good demand, and prices firm. Steel and ironworks fully employed, and prices for tin-plate bars have again advanced. Copper is slightly easier, but there is a fall in the price of tin. Exports for week ending 9th were:—Coal: Foreign, 64,964 tons; coastwise, 21,710 tons. Imports for week ending 12th were: Iron ore, 1700 tons; pig iron, 3690 tons; spiegel, 480 tons; manganese, 2800 tons; scrap, 190 tons; phosphate, 1000 tons; pitwood, 1829 loads; one cargo of boards.

Coal: Best steam, 18s.; seconds, 16s. 6d. to 17s.; house coal, best, 15s.; dock screenings, 11s. 6d. to 12s.; colliery small, 11s. to 11s. 6d.; smiths' coal, 11s. Pig iron: Scotch warrants, 65s. 5d.; hematite warrants, 72s. 1d. f.o.b. Cumberland; Middlesbrough No. 3, 64s. 9d. prompt. Iron ore: Rubio, 20s. 6d. to 21s.; Tafna, 19s. 6d. to 20s. Steel: Rails—heavy sections—£7 10s. to £7 15s.; light do., £8 10s. to £9 10s. f.o.b.; Bessemer steel tin-plate bars, £7; Siemens steel tin-plate bars, £7 2s. 6d., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 16s. to 16s. 3d.; Siemens—coke finish—16s. 3d. to 16s. 6d.; Pitwood: Very scarce. London Exchange Telegram: Copper, £72 5s.; Straits tin, £110 10s. Freights: Steady.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 30th.

THE unparalleled prosperity in the iron and steel industries, and the success which has attended the formation of trusts, is bringing about a very favourable feeling among Boston and New York financiers with relation to iron and steel investments for 1900. No plans have been laid for the investment of money, but quite a number are under consideration. A great many new requirements are springing up, and moneyed men will have the choice of enterprises. Among those things which are attracting no small share of attention, is the establishment of shipbuilding plants along the coast or on the lakes. The establishment of a deep waterway from the coast to the inland lakes is receiving serious consideration of the State of New York and of the National Government. This city feels its commercial supremacy seriously imperilled by the rising competition of competing ports all along the Atlantic coast, the Gulf of Mexico, and the St. Lawrence. A mighty commercial problem is presented, and merchants, manufacturers, and bankers have been aroused from a half-century dream of unimperilled supremacy to the fact that all little and almost unknown places are bleeding New York of its business.

The deepening of the Erie Canal to 14ft. is under careful consideration; the energy displayed on the other side of the northern border is not lost sight of. More canal building upon a gigantic scale is near at hand, and more railroad building than has been heard of for nearly twenty years is now under consideration. A great deal of next year's railroad building will be in the way of feeders to existing lines, which will be intended to increase traffic. Several long lines in the Rocky Mountains regions are in projection; much depends upon the course of the iron trade. Signs of warning have already been given against further advances, but necessities are so urgent that further advances would not surprise anyone. At the same time, mills are slowly catching up with orders in hand, and nothing but a phenomenal expansion of requirements will result in a weakening of prices. The outlook for 1900 is extremely encouraging, and if a prophecy was indulged in, the safer one to make would be that the requirements of 1900 will very far exceed those of this year. The financial situation throughout the country is quite satisfactory.

CATALOGUES.

Thomas Parker, Limited, Wolverhampton.—Illustrated pamphlet describing the Bootle Corporation Electricity Supply Works and description of Parker's Works at Wolverhampton.

J. H. Holmes and Co., Newcastle-on-Tyne.—New illustrated catalogue of Lundell motors. An excellent idea of the construction and the numerous applications to which these well-known motors can be put can be acquired from this nicely appointed work.

The Motor Manufacturing Company, Limited, Coventry.—Catalogue No. 4, motor carriages, vans, cycles. The vehicles illustrated in this list are constructed according to one of the following systems:—Panhard, Daimler, Iden, de Dion, and Bollée.

TRADE AND BUSINESS ANNOUNCEMENTS.—Mr. Joseph John King, informs us that he has converted his business into a limited liability company, and that in future the name of the firm will be Joseph John King and Sons, Limited.—Estler Bros. inform us that they have removed to 25, Laurence Pountney-lane, Cannon-street, London, E.C.

SOCIETY OF ENGINEERS.—The forty-sixth annual general meeting of the Society of Engineers was held on December 11th, at the rooms of the Society, 17, Victoria-street, Westminster. The chair was occupied by Mr. John Corry Fell, president. The following gentlemen were duly elected by ballot as the Council and officers for 1900, viz.:—As president, Mr. Henry O'Connor; as vice-presidents, Messrs. Charles Mason, Percy Griffith, and James Patten Barber; as ordinary members of Council, Messrs. Joseph Bernays, D. B. Butler, G. A. Pryce Cuxson, W. H. Holttum, R. St. George Moore, Nicholas J. West, Joseph William Wilson, and Maurice Wilson; as hon. sec. and treasurer, Mr. George Burt; as hon. auditor, Mr. Samuel Wood, F.C.A. During the scrutiny the President addressed the meeting, bringing before the members the salient points of the work of the past year. He also announced that the following premiums had been awarded by the Council for papers read during the past session, viz.:—The President's gold medal to Mr. E. Wynter Wagstaff, for his paper on "The Shan Hill Country and the Mandalay Railway;" the Bessemer premium to Mr. R. G. Allanson-Winn, for his paper on "Foreshore Protection, with Special Reference to the Case System of Groyning;" a Society's premium to Mr. Gordon Harris, for his paper on "Water Supply to Country Mansions and Estates;" and a Society's premium to Mr. Ewart C. Amos, for his paper on "Machine Tools." A vote of thanks was accorded to the scrutineers, and the proceedings terminated by a vote of thanks to the president, Council, and officers for 1899, which was duly acknowledged by the President.

NEWCASTLE-ON-TYNE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—A meeting of the local members of the Institution and of others interested in electrical science was held in the Durham College of Science on Wednesday evening, December 13th, at which the president of the Institution, Prof. Silvanus Thomson, D.Sc., F.R.S., and several members of Council, and the secretary of the Institution, Mr. W. G. McMillan, who had travelled down from London, were present. Mr. J. F. C. Snell, the temporary honorary secretary, read letters regretting inability to be present from the Duke of Northumberland, the Marquis of Londonderry, Sir David Dale, Bart., Sir Lindsey Wood, Sir Andrew Noble, K.C.B., the Bishop of Durham, the Dean of Durham, Prof. Weighton, C.E., Prof. G. H. Brady, Mr. J. W. Swan, F.R.S., Mr. W. C. Mountain, the Mayors of Newcastle, Sunderland, and Darlington, and several other gentlemen, all of whom expressed the wish that the local section may be launched and be a success in every way. The president explained the objects of the Association, and the desire of the parent Institution to further the interests of district sections. Mr. John Holmes proposed, and Mr. Jeckell seconded, that a memorial be signed to forward to the Council. This motion was carried unanimously. There were sixty-eight members present, and a provisional Committee was formed consisting of the Hon. C. A. Parsons, Messrs. Holmes, Mountain, Heaviside, Snell, Jeckell, and Burnett. Votes of thanks to the Rev. Principal Gurney and the president concluded the proceedings.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE German iron trade is in all departments very briskly employed, and the improving tone of the past weeks has been rather increasing. At a general meeting held at Kattowitz on the 25th of November the Silesian rolling mills resolved to raise bars, which were up to now quoted M. 195 p.t., free place of consumption, to M. 210 p.t.; and though this is quite an abnormally high price, there is good reason to expect it to be firmly maintained for at least some months, as it was caused by the extremely high prices that are quoted for raw material, and the latter are inclined to go up too, because production can hardly keep pace with consumption. An exceptionally strong demand is experienced for both forge and foundry pig, and present quotations are, in Silesia, for forge pig and basic, M. 80 p.t.; Bessemer, M. 87 to 88 p.t.; foundry pig, M. 93 p.t., free at works. Demand is improving in scrap iron, and this has led to a stiffening tendency in prices.

The manufactured iron and steel industries have never before been brisker than they are at present; there is no abatement felt in activity or demand, though some articles are, as a rule, but weakly called for at this time of the year. Most firms find it very difficult to keep pace with demand, as they have to wait so long for supplies in raw material.

The plate and sheet trades are in great prosperity. Spring orders are plentiful, both in heavy and light plates, and contracts for the second quarter in 1900 increase. Plates in basic last week stood on M 195 p.t.; for Siemens-Martin plates M. 200 p.t. was given, and boiler-plates in mild steel cost M. 205 to 210 p.t.; best sorts of heavy plates for boiler-making are even reported to have fetched up to M. 280 p.t., all free at works. All sorts of sheets are in very good call, and the Siegen mills have asked M. 210 p.t. for their best qualities.

Activity in the shipbuilding and engineering industries continues in all respects satisfactory, and the wire and hardware trades are likewise healthily engaged, though here, as in all other departments, the want of sufficient supplies in raw material delays seriously the execution of orders.

From the Austro-Hungarian iron market very little of interest can be told, as there is not much life stirring in the different departments. Demand and employment are regular, on the whole, but without animation. There has been a reduction in price for girders, which were formerly quoted 116fl. p.t., and are now sold at 111fl. p.t. From Hungary a good export in rails has been done to Italy, orders lately received amounting on 35,000 q., which have already partly been delivered to Venice, from where they are being sent further on by boat. Except for girders, all prices for iron and steel, raw as well as finished, can be stated to have been firmly maintained.

The manufacturers of agricultural machines from Vienna, Cracow, and Moravia have resolved to raise the prices for their articles with the beginning of next year, the advanced quotations for raw material rendering it impossible to sell machines at the former prices.

The Hungarian iron company Ganz and Co., is reported to have signed, at St. Petersburg, a treaty with the East China Railway Company, concerning the erection of a great electric central station at Port Arthur. The electric power is to be used, not for lighting purposes, but for the big cranes in the harbour of Port Arthur. The same Hungarian company has also obtained a stipulated promise that the building of other electric establishments will be granted it in those parts of China that have been rented by Russia.

The upward movement continues in the French iron and steel trades, and the tone all round is exceedingly cheerful.

In Belgium the position of the iron market is even brisker than it was last week. All the manufactured iron and steel industries are very actively engaged, a strong tone characterises prices, the tendency being in an upward direction.

Coal and coke are in brilliant request, and the demand continues in excess of the supply. Naturally prices are exceedingly firm.

LAUNCHES AND TRIAL TRIPS.

HEEMSKERK; built by, Cochrane and Cooper, Limited; to the order of, Van Vliet and Co., Ymuiden; dimensions, 115ft. 4in., 21ft. 6in., 11ft. 6in.; engines, triple-expansion, 13in., 21in., 34in., by 24in. stroke, pressure 180 lb.; constructed by, Sir Christopher Furness, Westgarth, and Co., Limited; trial trip, December 7th.

STANLEYVILLE, twin-screw mail and passenger steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, Compagnie Belge Maritime du Congo; dimensions, 382ft., 46ft., 25ft.; to carry, 108 first-class, 80 second-class passengers; engines, triple-expansion, 21½in., 34in., 59in., by 42in., pressure, 180 lb.; constructed by, Wallsend Slipway and Engineering Company, Limited; trial trip, December 7th.

SEAGULL, steel screw steamer; built by, Mackie and Thomson, Govan; to the order of, Leach and Co., London; dimensions, 225ft., 33ft., draught loaded 15ft. 4in.; engines, triple-expansion, 19in., 31in., and 51in., by 33in. stroke, pressure, 160; constructed by, the North-Eastern Marine Engineering Company, Limited; trial trip, December 9th; 12½ knots.

B. KEMENY, screw steamer; built by, R. Craggs and Sons; to the order of, Royal Hungarian Sea Navigation Adria Company, Limited; dimensions, 331ft., 42ft. 6in., 24ft. 9in.; to carry, 2736 tons gross; main machinery constructed by, the North-Eastern Marine Engineering Company, Limited; trial trip, December 11th; over 11 knots.

BEGONA, screw steamer; built by, the Tyne Iron Shipbuilding Company, Limited; to the order of Stag Line, of North Shields; dimensions, 345ft., 46ft., 27ft. 3in. moulded; engines, triple-expansion, 23in., 38½in., 64in., by 42in. stroke, pressure, 183 lb.; constructed by, the North-Eastern Marine Engineering Company, Limited; trial trip, December 9th; 12 knots.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

30th November, 1899.

23,847. ROTARY ENGINE, T. R. Smith, Jarrow-on-Tyne.
23,848. GAME, C. E. Hunter and T. S. Handley, Manchester.
23,849. CONVEYANCE of WINES, A. G. Macculloch, London.
23,850 FORK END for VELOCIPEDES, H. L. Davis, South Bristol.
23,851 SHAFTS for PERAMBULATORS, A. Davies and J. Hill, Birmingham.
23,852 AUTOMATIC LATHES, J. Anderson, Newcastle-on-Tyne
23,853 FOG SIGNALS F A. Ludlow Birmingham.
23,854. ROVING FRAMES, T. Buckley.—(*J. Buckley, Mexico*)
23,855. BOLTS, G Woodiwiss, Bradford.
23,856 SHIP'S PROPELLER SHAFT BEARING, A. Dalrymple, Liverpool.
23,857. PRINTING MACHINES, G. Bestwick, Manchester
23,858. PROCESS of MAKING NAPHTHA, G. Schumacher, London
23,859. WIRE MATTRESSES, R. E. L. Evans, Birmingham.
23,860. KNIFE for the USE of PAINTERS, J. Glennie, Glasgow.
23,861 RUPTURE APPLIANCES, T. C. and W. F. Waddell, Glasgow.
23,862. MAKING FANCY BRAID FABRICS, W. Bowden, Manchester.
23,863. CINEMATOGRAPHS, W. N. L. Davidson, Brighton.
23,864. FLEXIBLE TUBES, G Hookham, London.
23,865 NAVE for the WHEELS of CARTS, J. E. McIlroy, Glasgow.
23,866. MULTIPLE DUPLICATOR, J. Christie, Sheffield.
23,867. WASHING and DRYING MACHINERY, J. Burgess, Manchester.
23,868. PIPE JOINT, The Eltringham Sanitary Brick and Pipe Company, Sunderland.
23,869. ELECTRIC LAMPS, R. B. Ransome.—(*A. W. W. Miller, United States.*)
23,870 ELECTRIC TELEGRAPH APPARATUS, S. G. Brown, London.
23,871. LOCKS, G. H. Burrows, Wolverhampton.
23,872. CHAIR SEATS, J. Sutcliffe, Halifax.
23,873. STEERING SHIPS, D. de la M. du Boulay, Salisbury.
23,874. MAKING CALCIUM, F. L. Toby and O. S. Borch, London.
23,875. CUFF GRIP, R. Gardenner and D. R. Head, Reading.
23,876 SHEARING MACHINERY for TRIMMING FABRICS, H. Goodacre and W. Goodacre and Sons, Limited, London.
23,877. GAS LIGHTERS, H. de Thiersant and H. J. Norballe, London.
23,878. SECURING COLLAR STUDS, E. A. Lampey, London.
23,879. ELECTRIC INCANDESCENT LAMP, F. M. F. Cazin, London.
23,880. COATING PHOTOGRAPHIC FILMS, C. E. Hearson, London.
23,881. CONTROLLING MARINE ENGINES, A. M. Rust, London.
23,882. INCREASING STABILITY of SHIPS, F. Nockold, London.
23,883. ORGANS, C. T. Kühne, London.
23,884. STEAM GENERATORS, H. C. Bull and J. Ramage, London.
23,885 STRETCHER for BOOTS and SHOES, H. Janowitz, Liverpool.
23,886. KERBSTONES, W. C. Milburn, Birmingham.
23,887. LIFTING DOOR CURTAINS, G. Bingel and H. Hartley, Birmingham.
23,888. MACHINERY for DRYING YARN, C. Schrader and J Overman, London.
23,889. REDUCING FRICTION in BEARINGS, J. Lowthwaite and A. E. Williams, London.
23,890. NEEDLE HOLDERS, G. Korytowski, London.
23,891. PREPARING a SOLUTION of ACIDS, V. Rollet, London.
23,892. LIFTS, C. T. Burgess, London.
23,893. SPRAYING DEVICE, J. Morrison, Philadelphia, U.S.
23,894. PRINTING PRESS, C. G. Harris and J. F. McNutt, London.
23,895. OPERATING BOILER TUBE CLEANERS, P. Jensen.—(*The Union Boiler Tube Cleaner Company, United States.*)
23,896. PNEUMATIC TIRES for CYCLES, A. J. Mottlau, London.
23,897. INKSTANDS. A. J. Mottlau, London.
23,898. ENGINES, H. J. Lawson. London.
23,899. LABEL for ADVERTISERS' USE, M. S. Chatterton, London.
23,900. VEHICLE COUPLINGS, G. Aldridge and R. A. Anstey, London.
23,901. COSMETICS, C. von Huber, London.
23,902. MACHINE for WINDING YARNS, D. McTaggart, London.
23,903. SUPPLYING FURNACES with FUEL, H. Buderas, London.
23,904. COIN-FREED MECHANISM, R. Littlejohn, London.
23,905. ELECTRO-MOTOR, F. M. Lewis, London.
23,906. SUPPORTING ROPES, J. and J. R. Temperley, London.
23,907. SCARVES, F. Theak, London.
23,908. GUIDES for PAPER MACHINES, T. Harvey, jun., London.
23,909. FRAMES for WHEELS of CYCLES, W. Hewett, London.
23,910. SHAFT BEARINGS, J. and J. R. Temperley, London.
23,911. TREATING ORES, C. J. Head and R. C. Wild, London.
23,912. GEAR, W. Timmermann and H. Dellschafft, London.
23,913. DRIVING GEAR for BICYCLES, J. Jansen, London.
23,914. SOLDERING MACHINE, R. D. Hume, London.
23,915. GAS GENERATORS, J. W. B. Wright and W. Randle, London.
23,916. TRANSMITTING MOTION, A. Goodwin and A. T. Booth, London.
23,917. GLOVE, H. Haustgen, London.
23,918. INCANDESCENT FILAMENTS, L. de Somzée, London.
23,919. TYPE PRINTING TELEGRAPHS, J. Stockert, London.
23,920. REGISTERS for FIRE-GRATES, R. F. Loosemore, Tiverton, Devon.

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23,921. MACHINES for TRIMMING HEDGES, W. Houseman, York.
23,922. INTERLOCKING DOUBLE COUPLING, J. B. Cullen, Manchester.
23,923. MANUFACTURING TWISTED CORDS, H. Clarke, Nottingham.
23,924. SUBMARINE VESSELS, S. Lake, Manchester.
23,925 ELECTRIC SWITCHES, J. M. Hewitt and W. G. Rhodes, Manchester.
23,926. UMBRELLAS, A. Ingram and McGowan and Ingram, Ltd., Glasgow.
23,927. LUBRICANT COMPOSITION, J. R. E. Warren, Birmingham.
23,928. BEDSTEADS, W. M. Hoskins, Birmingham.
23,929. FENCES. T. G. Bonta, Glasgow.
23,930. BEET PULLERS, I. Goble, Glasgow.
23,931. SYRINGES, C. L. Akers, Glasgow.
23,932. LADIES BAG PROTECTOR, F. D. Thompson, London.
23,933. MEANS for CLEARING TRAM RAILS, P. B. Richardson, Sheffield.
23,934. EYES for STAIR RODS, M. Evans, Liverpool.
23,935. BERTHS for USE on BOARD SHIP, T. Christie, Glasgow.
23,936. MAKING DOOR KNOBS, G. H. Burrows, Wolverhampton.
23,937. GENERATING ACETYLENE GAS, A. E. Adolfsson, London.
23,938 BACK WHEEL RIM BRAKE for CYCLES, C. H. Shacklock. Wolverhampton.
23,939 ROWLOCKS for BOATS, G. Bulman. Liverpool.
23,940. PLACKET-HOLE FASTENER, M. Evans, Liverpool.
23,941 TYPEWRITING MACHINES, P. Waked, A. D. Macdonald, H. Steinemann, and A G. Mabardi, Manchester.
23,942 NIPPERS for MAKING GLASS BALLS, J. Simcox, St Helens, Lancs.
23,943. AUTOMATIC COUPLINGS, G. Tustin and E. Cumber, London.
23,944 AUTOMATIC DIS-MULTIPLIER, A. Didierjean, London.
23,945. SAFE STOCKS for HORSES, F. E. Smith, London.
23,946 MANUFACTURE of PROJECTILES, J. T. M. Hircock, Birmingham.
23,947. FIRE ENGINES, J. C. Merryweather and C. J. W. Jakeman, Kent.
23,948. DRIVING APPARATUS, C Dansard, London.
23,949 TRAVELLING BAGS A. J. Lewis, London.
23,950. CIGARETTE-MAKING MACHINE, H. H. H. Bobin, London.
23,951. PETROLEUM BURNERS, R. Fischbach and E. Seukbeil. London.
23,952 A NEW MIRROR, W. K. Fenchel London.
23,953. DOOR-HANDLE FASTENINGS, R. E. Phillips.—(*J. W. McDougall New Zealand.*)
23,954. DETONATORS, J. W. Fowler, London.
23,955. ATTACHMENT for CORSETS, L. M. Silverwood, London.
23,956. HARVESTING MACHINERY, H. R. Griffin, London.
23,957. DEVICE for BOLTING WINDOWS, J. S. Henry, London.
23,958. WHEELS for CYCLES, J. and J. R. Temperley, London.
23,959. WASTE VALVES, G. Curtis and G. Baumann, Brockley.
23,960. ELECTRIC SWITCH or GOVERNOR, E. Cros, London.
23,961. DREDGING APPARATUS, T. O. Newman, London.
23,962. HORTICULTURAL STANDS, &c., P. Lolasseur, London.
23,963. TAPS, H. H. Lake.—(*The Peck Bros. and Co., United States.*)
23,964. ARTIFICIAL STONE, C. Czerny and C. Schlimp, London.
23,965. APPARATUS for STRETCHING TROUSERS, D. Baker, London.
23,966. CURES, H. Roberts, London.
23,967. PROMOTING GROWTH of HAIR, C. E. Thwaites, London
23,968. ANTHRAQUINONE DYESTUFFS, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
23,969. FUSES, J. Wetter.—(*E. Rubin and H. Korrodi, Switzerland.*)
23,970. MAKING BLOOD PRODUCTS, A. J. Boult.—(*E. Richter, Germany.*)
23,971. TREATMENT of SEWAGE, &c, J. C. Thresh, London.
23,972. COIN-PROJECTING APPARATUS, C. J. Leather and E. Hollanders, London.
23,973. HAIR CURLERS and WAVERS, A. R. Edwards, London.
23,974. DUMB-BELLS, C. E. Adams, London.
23,975. COUPLINGS for RAILWAY VEHICLES, P. A. Dixon, London.
23,976. APPARATUS for CONSUMING SMOKE, P. Mathias, London.
23,977. SMOKE-CONSUMING FURNACE, M. G. A. H. Artigues. London.
23,978 SOLIDIFYING OILS, H. B Helbing and F. W. Passmore, London.
23,979. SOLIDIFYING OILS, H. B. Helbing and F. W. Passmore, London.
23,980. LINOTYPE MACHINE, W. P. Thompson.—(*J. R. Rogers, United States*)
23,981. LATTICE WINDOWS, W. P. Thompson.—(*The Westfälische Metall-Ornamenten Fabrik R. O. Leutert and Co., Germany.*)
23,982. GLUE-APPLYING MACHINERY, U. G. Charles, Liverpool.
23,983. DRESS and CLOTHING SUSPENDERS, V. Hiller, Liverpool.
23,984. SEWING MACHINE, A. Furnival, Manchester.
23,985. ROASTING COFFEE, R. Haddan.—(*G. Linde, Germany.*)
23,986. PRODUCING FOILS for DIE STAMPING, E. Oeser, London.
23,987. LEVELLING DEVICE for BUILDING, A. Gaefke, jun., London.
23,988. GENERATING GAS, H. H. Leigh.—(*J. W. Carey, Queensland.*)
23,989. VENTILATION of HATS, G. W. Salisbury, London.
23,990. MANUFACTURE of GLASS, &c., J. Lühne, London.
23,991. NON-REFILLABLE BOTTLES, H. Andrews, London.
23,992. LAMPS, W. Notley and C. E. Frost, London.
23,993. UP-TO-DATE DRESS-HOLDER, C. H. Edwards, Tenterden, Kent.

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23,994. MEANS for USE in PLAYING PIANOS, J. Jackson, Leytonstone, Essex.
23,995. KITCHEN BATH, E. and F. Darby, Birmingham.
23,996. SAWING and MITREING MACHINE, T. Wyatt and F. London, Witton, near Birmingham.
23,997. CHEESE CUTTER, T. Wyatt and F. London, Witton, near Birmingham.
23,998. CLIP for SQUARE-MOUTH BAGS, A. J. Wilkins, London.
23,999. SAFETY GAS LIGHTER, W. Denham, Birmingham.
24,000. CORNICE POLE and CURTAIN CLASP, A. Kay, Glasgow.
24,001. COMBINED KNIFE and FORK CLEANER, J. P. Wilks, Uttoxeter.
24,002. SUBSTITUTE for GLASS, J. E. Thornton and C. F. S. Rothwell, Altrincham.
24,003. REFRIGERATING DAIRIES, W. McDonnell, Kyleglas, Limerick.
24,004. INDICATING POSITIONS upon MAPS, H. McGowan, Glasgow.
24,005. AUTO-CAR STEERING GEAR, T. B. Browne and F. L. Martineau, Coventry.
24,006. FUMIGATOR, D. W. Fessey and F. M. Timmins, Birmingham.
24,007. DOBBIES for LOOMS, B G. Boulaye, Manchester.
24,008. TRIMMING for MILLINERY, E. W. Hunter, Leeds.
24,009. MACHINES for the MANUFACTURE of WIRE NETTING, W. H. Johnson and E. Pearson, jun., Manchester.
24,010. STENTERING MACHINES, Gartside and Co. and W. Warr, Manchester.
24,011. PRODUCING ALKALI CYANIDES, J. Grossmann, Manchester.
24,012. CLIPS for SECURING BOBBINS, L. and W. J. Flood, Preston.
24,013. GRATES, T. Metcalfe, Blackpool.
24,014. PUNCHING JACQUARD CARDS, S. A. Hickton, Glasgow.
24,015. BICYCLE BRAKE, R. Shanks and E. Bolton, Bolton.
24,016. FILE or BINDER for PAPERS, F. G. Burkitt Liverpool.
24,017. CENTRIFUGAL MACHINES, D. Willox, Glasgow.
24,018. WAGON COUPLINGS, W. and G. W. Drummond, Glasgow.
24,019. DRAWING BOARDS, S. Chandler, jun., and J. Chandler, London.
24,020 DRYING PHOTOGRAPHIC FILMS, E. K. Holmes, Canterbury.
24,021 PENHOLDER, R. Gauck, Glasgow.
24,022 CONDENSER, S. Couper, Glasgow.
24,023. STEAM GENERATORS. P. Kestner, Manchester.
24,024 CONCENTRATING LIQUIDS, P. Kestner, Manchester
24,025 PREVENTING LOOM CORDS BREAKING, W. Saumert, Berlin.
24,026 PENCIL CASE H. C Willmott. London.
24,027 ARTICULATOR, J. L. O Tilley, London.
24,028 DRIVING CHAINS for CYCLES, W. Brampton, Birmingham.
24,029. SIFTING HAY, J Eckersley and E. Chandley, London.
24,030 DAVITS, J. Hamilton. London.
24,031. BELT, E Dobson. London
24,032. ENVELOPES, W. Cartwright, Birmingham.
24,033. PENHOLDERS, R. H. Bishop and F. R. Baker Birmingham.
24,034 BOXES, F. Vogel, Berlin.
24,035 SPRAYING APPARATUS, &c., G. F. Strawson, London.
24,036. FURNACE FIRE BRILGE, S. H. and W. H. Baker, London.
24,037 BRAKE MECHANISM, H. Behrens, London.
24,038. WATER-TIGHT SLIDING DOORS, V. Arschaouloff, London.
24,039 PHOTOGRAPHIC APPARATUS, W. Britain, jun., London.
24,040. TYPEWRITING MACHINES, &c, J. J. Green, London.
24,041 MILK-TRANSFORMING APPARATUS, A. S. Maffei, London.
24,042. TINS, Bryant and May, Ltd., and A. E. Thorp, London.
24,043 AUTOMATIC GAS IGNITERS, K. Schultze, London.
24,044. TOY, A. Weigel. London.
24,045 TYPEWRITING MACHINES, J. S. Foley and J. H. Birch. London.
24,046. SAFETY DEVICES for RAILWAY TRACKS, V. Ullmann, London.
24,047. VESSELS, &c., A. J. Boult.—(*E. R. Krocker, Austria.*)
24,048. TELANTOGRAPH APPARATUS, F. Ritchie, London.
24,049. INTERCOMMUNICATION TELEPHONES, L. E. Wilson, London.
24,050. BOTTLES, F. F. Shelvey, London.
24,051. PNEUMATIC SADDLES for CYCLES, F. Bourchati, London.
24,052. PETROLEUM LAMPS, L. Bégenne-Lamotte, London.
24,053. MATCH-BOXES, H. H. Lake.—(*A. G. Hiihre, Norway.*)
24,054. SIGNALS for PASSENGERS and GUARDS, A. Spencer, Manchester.
24,055. FUEL, E. Springborn. London.
24,056. GAS SCRUBBERS, G. Zschocke. London.
24,057. APPARATUS for GRAIN DRYING, F. E. Otto, London.
24,058. CARRYING OFF GENERATED GASES, W. Bein, London.
24,059. CUTTING PAPER, H. H. Lake.—(*C. B. Cotterell and Sons Company, United States.*)
24,060. BURNERS, W. H. Drake and R. K. Pelton, London.

4th December, 1899.

24,061. PREVENTING WASTE of BEER, J. Watts, Birmingham.
24,062. PRODUCING CHANNELS in WOOD, R. Boughton and J. E. Smith, London.
24,063. DRIVING GEAR for BICYCLES, J. J. B. Arter, Birmingham.
24,064 CONSTRUCTION of CIGARETTES, W. C. Robison, Scarborough.
24,065. DRESSING TABLE, V. S. F. Wilson, Chobham, Surrey.
24,066. FOUNDRY LADLES, A. Eckenberg, Barmen, Germany.
24,067. ROTARY HEDGE CUTTER, J. Petrie, Glasgow.
24,068. GOVERNOR for TURBINES, G. M. Robertson, Glasgow.
24,069. SPRING FASTENERS for GLOVES, C. A. Pfenning, Manchester.
24,070. CHAMBERS for DRYING WOOD, T. A. Hearson, Englefield Green, Surrey.
24,071. COVERING RAILWAY TRUCKS with SHEETING, R. E. Mulvey, Stockton-on-Tees.
24,072. ATTACHING PEDAL PINS to CYCLE CRANKS, J. Martin and I. M. Weston, Wolverhampton.
24,073. SPRING FORKS for BICYCLES, D. Edwards, Liverpool.
24,074. A NEW AIR BRICK or VENTILATOR, E. Cowell, Burnley.
24,075. MACHINE for CUTTING BOOT LACES, F. Warburton, Derby.
24,076. EXPANSION JOINT for PIPES, J. F. Simpson, Manchester.
24,077. METALLIC PACKING for PISTON-RODS, J. F. Simpson, Manchester.
24,078. STOVES, H. Hebden. Harrogate.
24,079. CLIP for CABLES, O. Oldham and J. Forrest, Manchester.
24,080. DIRECT-ACTING PUMPS, R. A. Sloan.—(*W. H. Martin, Holland.*)
24,081. CLIPPERS for HORSES, T. Harrison, Birmingham.
24,082. GAS BRACKETS or PENDANTS, J. E. Britton, Leeds.
24,083. REGISTERS for COIN-FREED APPARATUSES, C. Lawrence, London.
24,084. HYDROCARBON OIL BURNERS, R. T. Brand, London.
24,085. TERMINALS for ELECTRIC CABLES, R. F. Hall, Birmingham.
24,086. ADJUSTABLE BRAKE BLOCK, C. Coward, London.
24,087. HOLDERS for CYCLES, M. Mitchell, Stafford.
24,088. PACKING for STEAM PISTONS, A. MacLaine, Belfast.
24,089. PHOTOGRAPHIC OBJECTIVES, P. Rudolph, Jena, Germany.
24,090. POCKET BAGATELLE FUZZLE, W. A. Dobson, London.
24,091. SELF-ACTING MULES, M. Musgrave, J. Walsh, and T. Kitchen, London.
24,092. TUBE CUTTERS, A. E. A. Wathier, London.
24,093. PNEUMATIC TIRES for CYCLES, A. B. Harrison, London.
24,094. PROTECTOR for WATER-CLOSET SEATS, E. J. Fairburn, London.
24,095. CHIMNEY for LAMPS, T. D. Curtis, Winslow, Bucks.
24,096. INCANDESCENT GAS BURNERS, C. S. Snell, Saltash, Cornwall.
24,097. GAS-COMPRESSING APPARATUS, C. S. and F. A. Snell, Saltash, Cornwall.
24,098. SKATES, H. Birkbeck.—(*The Samuel Winslow Skate Manufacturing Company, United States*)
24,099. ALARM CLOCKS, L. Schiff, London.
24,100. SKATES, H. Birkbeck.—(*The Samuel Winslow Skate Manufacturing Company, United States.*)
24,101. WASHING CELLULOSE THREADS, M. Fremery and J. Urban, London.
24,102. CYCLE BRAKE, J. H. Taylor and W. Habicht, Birmingham.
24,103. PLAYING INDOOR CROQUET, J. G. Warren, London.
24,104. GAS LIGHTERS, C. Vollmann, Barmen, Germany.
24,105. GUMMING MACHINES, E. Fischer, Barmen, Germany.
24,106. INDICATING STOPPAGE of OUTFLOW of the STUFF TAP in PAPER-MAKING MACHINERY, G. E. Jordan, London.

4,107. HEATING STRIPS of METAL, T. V. Allis, London.
4,106. PNEUMATIC WHEELS, J. A. Mays, London.
24,103. MATERIALS for PATTERN MODELLING, M. P. Browne, London.
24,110. CRAMPING TOGETHER BLOCKS of STONE, W. Shield, London.
24,111. WATER CARRIER, T. W. Wailes and G. F. Mason, London.
24,112. MACHINES for HAMMERING, L. Latkiewicz, London.
24,113. MEANS for SAVING LIFE at SEA, D. G. Martens, London.
24,114. FILTERING DEVICE for LIQUIDS, A. E. Frost, London.
24,115. STOPPERS for BOTTLES, T. Pusch, London.
24,116. ELECTRIC ACCUMULATORS, A. Perrin, London.
24,117. HAMMERS, H. Guyot, London.
24,118. LOCKS, P. Kossov, W. Wischew, P. Sofronow, and F. Naoumoff, London.
24,119. DOOR for STOVES and FIREPLACES, H. Svensson, London.
24,120. GAS LIGHTER, F. Juhász, Liverpool.
24,121. TABLES, J. A. Hartley, Liverpool.
24,122. CYCLES, E. R. Schmidt, London.
24,123. JOINING PIECES of ALUMINIUM ALLOY, M. Schmidt and Gesellschaft für Elektrische Metallbearbeitung G. M. B. H., London.
24,124. HEATING APPARATUS, W. L. Wise.—(*A. Kitson, United States.*)
24,125. SEWING THIMBLES, F. W. and M. Duke, London.
24,126. MAXIMUM DEMAND INDICATORS, A. Wright and The Mutual Electric Trust, Limited, London.
24,127. LITHOGRAPHIC PRINTING PROCESS, A. Duffek, London.
24,128. APPARATUS for DRIVING CARS, M. Herz, London.
24,129. SEATS, J. T. Faunt, London.
24,130. TICKET PUNCHES, L. Hartmann, London.
24,131. BORING WELLS, A. Fauck and A. Fauck, jun., London.
24,132. TOE-CLIP, T. G. Howden and H. W. Shaw, London.
24,133. ACETYLENE GAS BURNERS, C. S. Forbes, London.
24,134. NUT-LOCKS, T. R. R. Ashton, London.
24,135. RECOVERING ZINC from ORES, J. Gitsham, London.
24,136. SKIRT, K. Ryan, London.
24,137. SPINDLES, C. M. McQuilkin, London.
24,138. BRAKES, H. Wissner, London.
24,139. CONSTRUCTING FIRE-LIGHTERS, A. W. Redding, London.
24,140. APPLYING DRESSING to FELT, J. F. Giraud, London.
24,141. LIQUID FUEL-SUPPLYING ARRANGEMENTS for STEAM BOILERS, J. F. Flannery and W. Boyd, London.
24,142. ENGINES, J. Y. Johnson.—(*N. A. Guillaume, France.*)
24,143. PETROLEUM BURNERS, A. J. Boult.—(*G. Barthel, Germany.*)
24,144. COFFEE, L. T. V. Sommaire and T. Malen, London.
24,145. BOXES, A. J. Boult.—(*W. von Lilienthal, Germany.*)
24,146. PRESS, W. Sommer, London.
24,147. COMBUSTIBLE MATCH COMPOSITION, H. Suschny, London.
24,148. FURNACES, J. Lühne, London.
24,149. CIGAR BOXES, M. Brown and H. Moskovitz, London.
24,150. BOTTLES, J. V. R. V. Name and J. E. Stevens, London.
24,151. IMPLEMENT for BUTLERS' USE, B. Toulotte, London.

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24,152. The NEEDFULL, J. J. Chew, Haslington, Lancs.
24,153. PLUGS, J. L. Thom, Glasgow.
24,154. KETTLE, A. Hateley, Birmingham.
24,155. REGULATING LIGHT, R. Alexander.—(*A. B. Vanes, Cape Colony.*)
24,156. WHEELS for VEHICLES, W. J. Waters, Llantarnam, Mon.
24,157. SPLINT, C. F. Snook, London.
24,158. PROMOTING WATER CIRCULATION, B. H. Thwaite, London.
24,159. FRICTION GEARING, F. and F. Rough, Hereford.
24,160. MULES, R. Slack, Manchester.
24,161. PEDAL for GRAND PIANOFORTES, W. E. Conrad, Eastbourne.
24,162. TIME INDICATORS for CHESS, S. Walker, Liverpool.
24,163. PROCESS of BLEACHING COTTON, J. F. Copley, Huddersfield.
24,164. TABLE, T. Stanton, Sheffield.
24,165. APPARATUS for SOWING SEEDS, P. O'Reilly, Dublin.
24,166. BOILERS for HEATING WATER, T. Farrow, Halifax.
24,167. CARBONISING RAG, J. E. Tolson and D. Haigh, Halifax.
24,168. ASHPAN, W. Clayden, Woodhouse, near Nottingham.
24,169. HOLDERS for CANDLESTICKS, S. Hall, Manchester.
24,170. LIFTING MECHANISM, W. R. Green, Newcastle-on-Tyne.
24,171. METAL-SHEARING MACHINES, B. Wesselmann, Manchester.
24,172. MERCURY VOLTAMETER, M. C. Clutterbuck, Brighton.
24,173. WEAVING LOOMS, J. C. Cottam and J. Bentley, Bradford.
24,174. NET, T. F. Adamson and E. Clarke, Newcastle-on-Tyne.
24,175. PROPELLING MOTOR CARS, F. W. Dickinson, Leeds.
24,176. MOUTHPIECE for CIGARETTES, E. Whittle, Warrington.
24,177. PROJECTILES, J. Stephens, Stonehouse, Gloucestershire.
24,178. DEVICE for LOCKING BOLTS, J. Macdonald, Glasgow.
24,179. LOCKING BOLTS and NUTS, D. Macdonald, Girvan.
24,180. WIRE WRITING on SUBSTANCES, A. F. Mason, Plymouth.
24,181. IMPLEMENT for SCRAPING PAINT from FURNITURE, F. H. Crocker, Kansas City, U.S.A.
24,182. PRESSES for WEARING APPAREL, J. R. Watts, Sheffield.
24,183. MAIL BOXES, B. F. and A. C. Brockmeyer, London.
24,184. ELECTRICALLY-PROPELLED VEHICLES, F. J. Newman and J. Ledwinka, London.
24,185. FLUSHING TANKS, H. M. Williams, London.
24,186. MULTIPLE-BLADE STARTING SWITCHES, W. Fairweather.—(*Crocker-Wheeler Company, United States.*)
24,187. OPENING the DISCHARGE VALVES of BATHS, J. Simpson, Glasgow.
24,188. MERCERISING FABRICS, J. R. Eoob, Keighley.
24,189. INDICATING the SLACKENING of a NUT, L. Parker, Leeds.
24,190. DOVETAIL SKID PAN and SHOE, G. A. Brown, Walthamstow.
24,191. ROPE DRIVING in COTTON MULES, J. Booth and J. Allen, London.
24,192. FLUID METERS, S. A. Chesley, London.
24,193. STEAM BOILERS, E. McConville, London.
24,194. RUBBER HEELS for BOOTS, C. S. Ferguson, London.
24,195. COMPOSITION for PREPARING MOULDS, H. L. W. Tamplin, London.
24,196. THERMOSTATIC ELECTRIC SWITCHES, G. Harrison.—(*The Auto-Protective Appliance Company of West Virginia, United States.*)
24,197. DIVIDERS for HARVESTER MACHINES, C. M. Coulter.—(*W. A. Wood's Mowing and Reaping Machine Company, United States.*)
24,198. RAILS for MOTOR VEHICLES, J. A. Mays, London.
24,199. TABLE GAME, J. E. Tomlinson, London.
24,200. RATCHET CLUTCHES for CYCLES, W. Hampson, London.
24,201. CHANGING PHOTOGRAPHIC FILMS, C. J. Bannister, London.
24,202. LAMPS for CARRIAGES, P. J. Thomas, London.
24,203. GENERATING GAS from GASOLINE, M. Posno, London.
24,204. ROTARY STEAM ENGINES, C. Griffin, London.
24,205. AUTOMATIC SKETCHING PROTRACTOR, R. S. Stewart, London.
24,206. CYCLE GEAR, W. H. Berryman, London.
24,207. VEHICLES DRIVEN by PEDALS, F. M. Castleman, London.
24,208. ELECTRICALLY-CONTROLLED LOCKING MECHANISM for COLLECTING BOXES, H. H. Lake.—(*F. Williams, United States.*)
24,209. MULTIPLE DRILLING MACHINES, F. V. Simpson, London.
24,210. GAME of CHESS or DRAUGHTS, G. Simmins, London.
24,211. TOYS, F. J. Gustine and B. T. Walshe, London.
24,212. SUPERHEATING STEAM APPARATUS, H. Szamatolski, London.
24,213. SUGAR POWDER, A. Vallez and F. Giraud, London.
24,214. CIGARS, H. H. Lake.—(*T. E. Carpenter, United States.*)
24,215. ABDOMINAL PAD and HOSE SUPPORT, E. F. Young, London.
24,216. SELF-CLOSING TAPS, L. E. Cowey, London.
24,217. SEWING MACHINES for BOOTS, J. E. Bertrand, London.
24,218. STEAM-BOILER FURNACES, H. H. Lake.—(*A. Freeman, United States.*)
24,219. STEAM TRAPS, C. H. Whitaker and A. C. Whiting, London.
24,220. BREECH MECHANISM for QUICK-FIRING GUNS, A. F. Watton, London.
24,221. RESILIENT TIRE for CYCLES, J. Lewthwaite, London.
24,222. MOTOR CYCLES, C. M. Linley, London.
24,223. LOCOMOTIVE FURNACES, F. Schröter, London.
24,224. STONING CHERRIES, B. Janet and A. Derunge, London.
24,225. COLLAR STUD and TIE HOLDER, P. A. E. Montgomery, London.
24,226. BUTCHER'S TICKET and ADDRESS HOLDER, J. W. Aggus, Ilford, Essex.
24,227. STAIR TREADS, H. H. Lake.—(*F. W. Huestis, United States.*)
24,228. CONDUCTORS for ELECTRICAL RAILWAYS, S. E. Gunyon.—(*H. Privat, Germany.*)
24,229. HEDGE CLIPPERS, J. Juritsch and A. Ohrfandl, London.
24,230. ANODE for USE in ELECTROLYSIS, I. L. Roberts, London.
24,231. ELECTRICAL MASSAGE RUBBING, B. and B. Kellerman, London.
24,232. PNEUMATIC HORSE COLLARS, F. R. Brooke, London.
24,233 FABRICS POSSESSING THERAPUETIC PROPERTIES, O. Troplowitz, London.
24,234. NEW FABRIC, E. Goldschmidt, London.
24,235. SOAP PRESSES, J. J. Forster and R. L. Murdock, London.
24,236. HEATING LIQUIDS, H. Voigt, London.
24,237. TREATING DYED FIBROUS MATERIAL, H. E. Aykroyd and P. M. Krais, Liverpool.
24,238. COMPOSITION of MATTER, W. McL. Scott, Liverpool.
24,239. MACHINES for SHAPING BOTTOMS of SHOES, E. Duplessis, Liverpool.
24,240. MEDICAL CAPSULES, K. Morstadt, Liverpool.
24,241. SLEEVE-FASTENING DEVICES, H. C. Ford and A. M. Lindsay, Liverpool.
24,242. GLASS GLOBES, W. C. Morison, London.
24,243. DREDGE PLOUGH, T. O. Newman, London.
24,244. ELECTRIC ARC LAMPS, E. H. Belden, London.
24,245. AIR TUBES for PNEUMATIC APPLIANCES, W. Bartsch, London.
24,246. BEARD and MOUSTACHE GUARDS, O. Sörgel, London.
24,247. TRAMWAY POINTS, R. A. Hadfield and A. G. M. Jack, London.
24,248. RUNNER-BOXES for CASTING INGOTS, A. A. Caspersson, London.
24,249. VESSELS for PROVISIONS, J. Marshall, London.
24,250. ROTARY MOTORS, C. MacArthur, A. T. Maclachlan, and A. B. Collis, London.
24,251. COIN-FREED AUTOMATIC MACHINE, J. C. Russell, London.
24,252. SEAMS for SEWED ARTICLES, J. G. Lewis, London.
24,253. SAND-BLAST APPARATUS, J. M. Newhouse, London.

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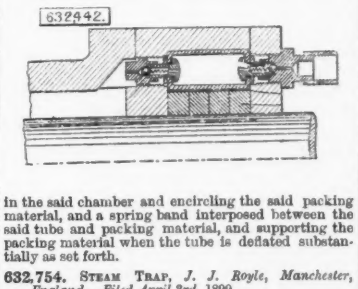
24,254. CYCLE BRAKE, L. Haslam, Manchester.
24,255. VEHICLE TIRES, G. Gibson, Liverpool.
24,256. ANCHORS, H. Hutchinson, Manchester.
24,257. MANUFACTURING BULLETS, J. Campbell, Glasgow.
24,258. CRANIOMETER CALLIPERS, D. Hepburn, Edinburgh.
24,259. MILK FEVER DRAUGHT for COWS, T. T. Tims, Banbury.
24,260. HEAD SCREEN for HORSES, H. G. Smith and E. Horton, London.
24,261. SWIVEL, G. W. Dickinson and R. H. Garlick, Manchester.
24,262. REVOLVING OVEN, J. W. Petavel, Sheffield.
24,263. RESPIRABLE MIXTURES, R. Marston, Leicester.
24,264. SMOKE-CONSUMING APPARATUS, M. H. Berry, Keighley.
24,265. ACETYLENE GAS GENERATORS, R. H. and F. Sunderland and G. Marshall, Birmingham.
24,266. SCREEN for INFANTRY in ACTION, W. Harrison, Manchester.
24,267. WATER-CLOSET CISTERNS, A. and D. Thomson, Carlisle.
24,268 HOLDING PLATES on TABLES, T. Gourley, Glasgow.
24,269. INCANDESCENT LAMP HOLDERS, A. Marr, Manchester.
24,270. AFFIXING DOWN PINS, F. H. Shaw, Birmingham.
24,271. "PLUCKING" RABBIT SKINS, T. C. Mills, Dublin.
24,272. BOX for HOLDING NEEDLES, R. Wheatley, jun., Birmingham.
24,273. TRANSMITTING ENERGY, J. E. Farrow, South Shields.
24,274. SEWER-DISINFECTING APPARATUS, J. Arnold, London.
24,275. BLEACHING PAPER, &c, J. C. Butterfield, London.
24,276. HERMETICALLY SEALING METALLIC BOXES, A. Lovell and G. Fincken, Kingswood.
24,277. PILE DRAWERS, W. P. Weir, Glasgow.
24,278. GAUGES for CARD TRIMMERS, J. Christie, Sheffield.
24,279. INKSTANDS, H. G. Froud, Wallisdown, near Bournemouth.
24,280. STANDS for STORING CYCLES, A. H. Baird, Liverpool.
24,281. BRICKS, O. Howl, London.
24,282. BASKETS, H. Stainsby, London.
24,283. BASKETS, H. Stainsby, W. J. Postle, W. G Whyley, and J. S. Furse, London.
24,284. TETHER for HORSES, &c, J. Layfield, Manchester.
24,285. SHUTTLE, E. Holding and M. Phillipson, Preston.
24,286. GAME, C. H. E. Clarke and R. C. M. Marcham, Manchester.
24,287. FIRE-GRATES and FURNACES, T. Mathison, London.
24,288. WATER HEATERS, A. C. Moffatt, London.
24,289. DOMESTIC STIRRER, F. A. Hunt, Thornton Heath, Surrey.
24,290. TROLLEYS, F. W. Brampton, Birmingham.
24,291. ARTILLERY GUNS or ORDNANCE, M. A. Wier, London.
24,292. SECURING CURTAINS to RODS, P. Wiesner, Berlin, Germany.
24,293. SYPHONIC FLUSHING APPARATUS, C. F. Dixon, London.
24,294. BEDSTEADS, A. Oates and R. P. Cockburn, London.
24,295. PORTABLE EXERCISING APPARATUS, M. B. Ryan, London.
24,296. AZO DYE-STUFFS for COTTON, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
24,297. ACCUMULATORS, J. B. Relin and C. A. Rosier, London.
24,298. PREVENTING the RAMMING ACTION of LIQUIDS in PIPES, P. Planquart, London.
24,299. CYCLE WHEELS and BRAKES, B. Poynton, Birmingham.
24,300. SURFACING DYNAMO COMMUTATORS, T. H. Nash, London.
24,301. FRAMEWORK of CYCLES, J. D. Derry, London.
24,302. GAS-WASHING APPARATUS, W. C. Sellar, London.
24,303. HAT VALISES, N. F. Hurdel London.
24,304. HEATING FLUIDS, E. Edwards.—(*L. C. Nielsen and P. V. F. Petersen, Denmark.*)
24,305. DASH-POT MECHANISM, R. H. Rice and J. W. Sargent, London.
24,306. EVAPORATING APPARATUS, H. H. Lake.—(*The Firm of Nicolo Odero Fu Alessandro, Italy.*)
24,307. PURIFYING ALKALINE CYANIDES, T. Wilton, London.
24,308. WARMING APPARATUS, L. Meunier and I. Gousset, London.
24,309. DRESS HOOKS, L. Hoffmann, London.
24,310. COIN-FREED APPLIANCES, F. J. Beaumont, London.
24,311. COUPLING RECEPTACLES to ROPES, M. Schimpf, London.
24,312. CYCLES, A. G. Bicknell, London.
24,313. HEATING WATER, H. Holden and R. G. Brooke, London.
24,314. CLOSING CRANK CHAMBER OPENINGS, W. Sisson, London.
24,315. BADGE PINS, W. Jones, Liverpool.
24,316 PROTECTING, &c., PNEUMATIC TIRES, H. Pass, Liverpool.
24,317. FURNACE GRATES, J. E. Slack, Manchester.
24,318. FURNACES for BURNING REFUSE, H. Heenan, Manchester.
24,319. PHOTOGRAPHIC SHUTTERS, The Thornton-Pickard Manufacturing Company, Limited, and C. G. Woodhead, Manchester.
24,320. FOLD-UP APPLIANCES for SEATS, C. F. Hengst, London.
24,321. TREES for BOOTS and SHOES, W. Belden, sen., London.
24,322. STEAM HOISTING ENGINES, J. and J. R. Temperley, London.
24,323. BENDING ELECTROTYPES, I. Lam, London.
24,324. CHAINS for CHAIN-WHEEL GEAR, C. B. Holmes, London.
24,325. ELECTRIC ARC LAMPS, J. A. Fleming, London.
24,326. EXTRACTING LIQUID CONTENTS from BOTTLES, E. H. Whiting, London.
24,327. STAIR LIFTS, J. M. Dodge, London.
24,328. CARBURETTORS, A. J. Boult.—(*A. Longuemare, France.*)
24,329. TYPEWRITING MACHINES, J. F. Hardy, London.
24,330. TYPEWRITING MACHINES, J. F. Hardy, London.
24,331. TYPEWRITING MACHINES, J. F. Hardy, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

632,442. ROD PACKING, *R. E. Byle, H. A. Fillmore, and R. H. Nicholson, Wilkes-Barré, Pa.—Filed November 26th*, 1898.

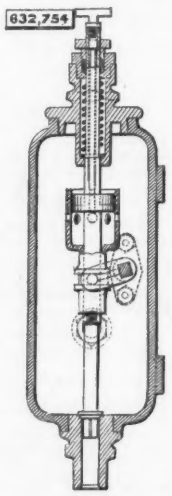
Claim.—The combination, with a packing chamber, of an annular ring of packing material arranged in the said chamber, an annular inflatable tube seated



in the said chamber and encircling the said packing material, and a spring band interposed between the said tube and packing material, and supporting the packing material when the tube is deflated substantially as set forth.

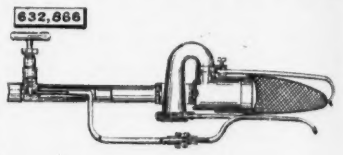
632,754. STEAM TRAP, *J. J. Royle, Manchester, England.—Filed April 3rd*, 1899.

Claim.—(1) In an apparatus for discharging water of condensation or priming, from a steam apparatus, a casing, a valve controlling the outlet from the casing, a cup reciprocated continuously from the exterior of the casing, and a piston on the stem of said valve, adapted to be received by the said cup. (2) In combination, a casing or vessel for receiving water of condensation, inlet and outlet openings, a valve for controlling said outlet, a spindle connected with said valve, a piston fixed on said spindle, a cup or cylinder with openings or ports loosely mounted upon said spindle and surrounding the piston, and means for imparting reciprocating motion to said cylinder, as set forth and for the purposes described.



632,866. PETROLEUM INCANDESCENT LAMP, *C. C. Bruckner, New York, N.Y.—Filed August 22nd*, 1898.

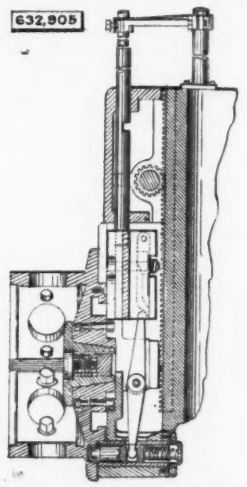
Claim.—The combination with a Bunsen burner and a mantle supported above the same and a mixing chamber adjacent to the hollow base, of a small generator tube passing up and down and exposed to the heat of the flame, with a larger metallic tube



attached at each end of such tubular generator, such enlarged ends being substantially parallel, and one of them having a hole forming a jet-opening, and the other receiving a coupling connection to the tube supplying the liquid hydrocarbon, substantially as set forth.

632,905. TURRET LATHE, *A. Swasey and H. M. Lucas, Cleveland, Ohio.—Filed March 27th*, 1899.

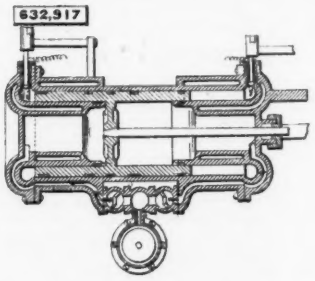
Claim.—(1) A lathe turret, consisting of a base plate capable of being rotatably supported on the turret slide, and a plurality of connected plates, which are fast to the outer face of said base plate, and have parallel outer and inner faces, and are symmetrically arranged about the axis of the base plate whereby to form an equilaterial polygon both internally and externally, each of said sides being provided with a hole for the passage of the work, and with means whereby a tool may be attached as well to the inner as to the outer face thereof, substantially as and for the purpose specified. (2) In a turret lathe, the combination of the turret slide and a turret base plate rotatably mounted thereon, and having on its under



side a plurality of vertical pins, with a sliding block mounted on the turret slide, a stem secured to said block and extending beyond the rear end of the slide, a spring pawl mounted on the top of said block, and having a concave front end for engagement with said pins, a lever engaging with said stem, and a spring for operating said lever, and an adjustable abutment for the stem of said block, whereby the block will be brought to rest while the slide is moving rearward, substantially as and for the purpose specified.

632,917. EXPLOSIVE ENGINE, *C. R. Daellenbach, Ellwood City, Pa.—Filed October 1st*, 1898.

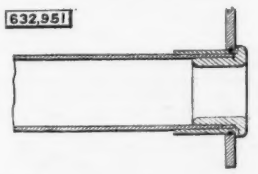
Claim.—In an explosive engine, the combination of a piston-cylinder having compression chambers at its opposite ends, explosion chambers surrounding said compression chambers, exhaust ports communicating with the explosion chambers, and a passage interposed between and connected at its ends with the explosion chambers, and provided with the inwardly-



directed ports adjacent to said ends, a tubular piston snugly fitting the explosion chambers and having a diaphragm at an intermediate point of its length, movable between the compression chambers, and also having ports at opposite sides of said diaphragm and adapted to register with the ports of said passage, and suitable means for igniting the explosive in the explosion chambers, substantially as specified.

632,951. FLUE FOR TUBULAR BOILERS, *A. Taggart, jun., Allegheny, Pa.—Filed March 11th*, 1899.

Claim.—A boiler flue comprising a hollow cylindrical tube, a ferrule suitably mounted thereon, and projecting outwardly therefrom, said ferrule provided with



an annular groove, a flue sheet provided with an opening adapted to receive the said ferrule and tube, the walls of the said opening in the flue sheet provided with the annular groove registering with the groove formed in the ferrule, a fastening wire arranged in the said grooves, and means inserted in the said tube for securing the ferrule and tube to the flue sheet, substantially as set forth.

THE COST OF CALCIUM CARBIDE.

WITH the exception presumably of the shareholders in the various manufacturing companies, there is a general consensus of opinion that at least in this country the acetylene industry is somewhat unduly handicapped in its efforts to make headway by the exorbitant price demanded for calcium carbide. Including the charges for carriage, &c., carbide is scarcely to be procured in English villages and rural districts some distance from a railway station at less than 26s. or 28s. per cwt. The price may perhaps be lower in towns; but it is the countryman who is primarily interested in lighting by means of acetylene, and only in such neighbourhoods as are too thinly populated to support a coal-gas works of reasonable size and properly controlled, can calcium carbide hope to find much of a market. The acetylene industry is, indeed, in a far weaker position with us than seems to be the case on the Continent. One of its competitors is more powerful; its supporters appear less energetic or judicious. On the one hand, coal gas can be made and sold more cheaply in small places here than abroad, wherefore the chances of successfully conducting a village acetylene installation in England are far less hopeful; on the other hand, the manufacture of carbide on the Continent is no longer protected by "master" patents, and competition is beginning to make itself felt in lower prices and more certain delivery.

In order to show the great advances that have taken place in the dimensions of the carbide business in almost all civilised countries save Great Britain, the following table condensed from a lecture delivered by Dr. Borchers last summer before the "Verein Deutscher Ingenieure" may advantageously be consulted. The figures, perhaps, are not correct in all instances, but the list is the most complete and trustworthy yet drawn up:—

Country.	No. of works in operation.	Horse-power employed.	H.P. of proposed enlargements.	No. of works building or projected.	H.P. of latter.
Austria	5	18,550	2,500	2	1,500(?)
Canada	1	1,500	—	1	(?)
France	20	42 790	10,500	—	—
Germany	6	12,440	—	—	—
Great Britain	3(?)	1,600	1,000	1	4,500
Italy	4	8 850	20,600	—	—
Norway	2	11,500	10,000	—	—
Russia	2	3,500	4,000	—	—
Spain	1	2,500	2,500	—	—
Sweden	1	(?)	25,000	—	—
Switzerland	7	19,100	6,650	2	7 000
United States	6	17,300	2,500	3	60,000

One or two of the larger European factories included above will not be working at full pressure before the approaching winter begins; but by the end of this year, some sixty works will be employing about 139,000-horse power in the manufacture of calcium carbide throughout the world, and should produce at the approximate output of 1 ton per electrical horse-power year, roughly 400 tons per day of 24 hours. This quantity should equal 4·5 million cubic feet of acetylene—a volume that comes near the regular make of the Gas Light and Coke Company, of London, being, in fact, about 77 per cent. of the coal gas manufactured by it according to its last half-yearly report. Including all the plants now building and projected, Dr. Borchers estimates the world's production as nearly 255,000 tons of carbide per annum which corresponds to some 850 tons per day. It is not proposed to continue this calculation further, or various more or less instructive data might be submitted. Enough has been said to show that the preparation of calcium carbide does merit the name of an "industry;" and that acetylene does meet with approval somewhere, though electricians, gas makers, and oil refiners each aver it is no rival of theirs.

In the present state of thermo-chemistry it is impossible to determine with any great degree of accuracy the theoretical amount of energy absorbed in producing a unit weight of calcium carbide. This is unfortunate, because although a substance can never be made on the large scale in strict accordance with thermo-chemical requirements, yet when they are thoroughly known, it becomes feasible by comparing the process with others of a similar nature to ascertain whether it is reasonably efficient, whether it is likely to be improved or superseded in the future, whether, in a word, it is commercially satisfactory. One, if not two, fundamental data are still lacking from the thermo-chemistry of the reaction between quicklime and carbon; the minimum temperature at which calcium carbide is formed cannot be calculated exactly, because the heat of formation of calcium oxide at high temperatures has not been examined; and for the same reason, coupled with some uncertainty as to its mean specific heat between 0 deg. C. and the temperature of the electric furnace, the necessary number of calories per gramme-molecule of carbide can only be approximately deduced.

As a matter of interest, albeit no sound conclusions can be based on the results, it may not altogether be loss of time to observe that in a partially similar case all the needful data have been worked out. In Richards' book on aluminium[1] the thermo-chemistry of the reduction of aluminium salts is carefully elaborated, and, founded on experiments with Minet's process for reducing the metal, the author has calculated the heat of formation of alumina at high temperatures. Aluminium and calcium stand very near one another in the list of chemical elements; but they differ in that calcium forms a monoxide, whereas aluminium yields a sesquioxide. Richards gives the heat of formation of one molecule of alumina at any temperature, t deg. as:

$$Al_2O_3 = 387{,}200 + 192\,t - 0{\cdot}1766\,t^2$$

where 387,200 is its heat of formation in small calories[2] from liquid aluminium at 0 deg. C. The heat of formation of calcium oxide has stood at Thomsen's figure 131,360 cals. until last year, when Moissan reinvestigated the problem by the aid of his crystallised metallic calcium,[3] and found it to be 145,000. Substituting this value in Richards' equation, and dividing the other variables by 3, the equation for calcium oxide becomes:

$$CaO = 145{,}000 + 64\,t - 0{\cdot}0589\,t^2.$$

For the sake of uniformity Richards' calculation of the heat of formation of carbon monoxide at high temperatures may also be adopted:

$$CO = 27{,}785 + 2{\cdot}88\,t - 0{\cdot}0003\,t^2,$$

and the heat of formation of calcium carbide has been found by Forcrand[4] to be − 650 cals. Now to calculate the temperature required by the equation

$$CaO + 3C = CaC_2 + CO,$$

that is, to calculate the temperature at which carbon reduces lime and combines with calcium, it is necessary to determine the temperature at which the heats of formation of carbide and carbon monoxide balance the heat of decomposition of calcium oxide. Expressed as an equation this becomes:

$$145{,}000 + 64\,t - 0{\cdot}06\,t^2 = 27{,}785 + 2{\cdot}88\,t - 0{\cdot}0003\,t^2 - 650;$$

solving this as an ordinary quadratic,

$$t = 2007 \text{ deg. C.}$$

In plain language, supposing at high temperatures calcium oxide behaves chemically like alumina, calcium carbide should be produced from quicklime and graphite at a heat not greatly exceeding 2000 deg. Cent. This result is considerably lower than that which is usually quoted as the temperature of formation; and yet there is little cause to believe it very wide of the mark. Nevertheless, the calculation must be distinctly understood to be purely speculative, and it awaits substantiation or refutation at the hands of some one who shall take up the thermo-chemistry of lime more fully. In the parent instance, carbon should reduce alumina at 1980 deg. Cent.,[5] whereas it is known to all students of the subject that the process is practically impossible without the assistance of the electric furnace and of metallic copper to assist in the operation. Hence at once arises an important point, for it may fairly be asked if alumina, which should be reduced by carbon below 2000 deg. Cent., cannot be converted into metal on the large scale by sheer smelting except in the electric furnace, how shall calcium carbide, which demands a temperature over 2000 deg. Cent., ever be manufactured non-electrically?

Within the last few years Violle[6] has determined the mean specific heat of carbon between 0 deg. Cent. and any temperature above 1000 deg. Cent. as

$$C'_t = 0{\cdot}355 + 0{\cdot}00006\,t,$$

whence he calculates its boiling point to be 3600 deg. Cent. This, then, is obviously the maximum; or rather, the temperature of an electric furnace in which calcium carbide is being made must be kept below 3600 deg.; more especially so because with a sufficiently intense arc calcium carbide is dissociated at a temperature below that at which carbon volatilises[7]; or in Moissan's words[8] calcium carbide can be completely decomposed, even in presence of excess of carbon, by an arc from a current of 1200 ampères and 60 volts without volatilising the carbon. Moreover, the necessity for working the electric furnace at the lowest practical temperature, apart from all considerations of economy, is emphasised by the above thermal equation for the production of carbide. The heat of formation of calcium carbide is a very insignificant item in comparison with the heat of decomposition of lime; therefore, with a trifling thermometric rise above the minimum temperature, there is a rapidly growing tendency towards a secondary reaction between the carbon and the calcium oxide, which should produce metallic calcium instead of calcium carbide. Carbide itself is endothermic, so that all the physical conditions must be perfectly suitable before it can be produced; and even then the process demands far more care than it would were the material strongly exothermic. Fortunately, its negative heat of formation is small, or it would dissociate again as quickly as it was formed.

If calcium carbide is to be suitable for the generation of acetylene, it must be kept as free as possible from any impurities capable of reducing the illuminating power of the final gas. Metallic calcium is only attacked slowly by water at ordinary temperatures, but it is attacked, and hydrogen is evolved[9] which, of course, burns with a non-luminous flame. Liquid or nascent calcium is soluble in molten calcium carbide[10]; if, therefore, the substance dissociates, or the metal is produced directly, the value of the resulting acetylene is greatly diminished. That these theoretical considerations are correct is borne out by practical experience. To win carbide in a state of satisfactory purity, it must be removed from the direct influence of the electric arc immediately the reaction is finished; if it is kept exposed to a high temperature for any length of time it deteriorates steadily and rapidly. Simple re-melting will cause a sample of known composition to generate 12 per cent. less gas than it did before, a second fusion more than doubles the loss, while fusion in the oxyhydrogen blowpipe decomposes calcium carbide almost entirely into carbon, calcium carbonate, and lime[11].

Returning now to more firmly trodden paths, it is usually assumed that the temperature at which calcium carbide is actually produced is 3000 deg. Cent. Lewes states distinctly that it is 2700 deg., but he does not explain whether this figure is the result of calculation or experiment. In a paper read before the last Acetylene Congress at Budapest, Gin[12] gives it as 3300 deg.; but this appears to be simply his own suggestion, and not proved by direct evidence. There cannot be any serious error in taking the first as the true working temperature; and if this proposition be accepted, one of the two unknowns in the thermo-chemistry of carbide manufacture is found. To calculate the thermal requirements of the reaction between lime and coke at 3000 deg. Cent., it is necessary to add together the calories absorbed in heating the lime and the three atoms of carbon, and the heat needed to decompose the calcium oxide, subtracting from the sum the heats of formation of calcium carbide and of carbonic oxide. At first sight this is a simple calculation, and it has been attempted by various writers, notably Butterfield,[13] who quotes the total per gramme-molecule of carbide as 163·5 cals., and Fowler,[14] who quotes 200·87. Fowler has made a curious error, including in his estimate the heat of formation of acetylene instead of that of calcium carbide; but apart from this, both calculations are more or less vitiated by the employment of the specific heats of the several ingredients and resultants as they exist at ordinary temperatures, without proper allowances for the increase in the said specific heats as the materials become hot. This is quite analogous to the calculations of the theoretical temperature of coal and producer gas, &c., burning in air, which are freely reproduced in all text-books, and which, being cursed—for the most part—with the same fundamental defect, are utterly devoid of value, in no way corresponding to the observed temperatures of combustion. Gin[12] has made a more careful calculation, with, apparently, all the necessary corrections, and he has specially determined the specific molecular heat of quicklime at high temperatures, finding it to be $11{\cdot}4 + 0{\cdot}001\,t$.

His total per gramme-molecule of carbide is 212 cals.; but as already mentioned, he has worked out his result on the assumption that the temperature is 3300 deg. Cent., while his heat for the formation of calcium carbide is taken, without explanation, at 3·9 cals. The following is a still further essay at the same calculation, using the latest determinations of the various constants which we have been able to discover. The temperature is taken at 3000 deg.; the formula for the heat of carbon is Violle's; for lime, Gin's; for the decomposition of calcium oxide, Moissan's; for the formation of carbon monoxide, Berthelot and Matignon's figure 26·1[15] with Richards' corrections given previously; for the formation of calcium carbide, Forcrand's value. The various items stand thus:

Heating 3 C to 3000 deg. $(0{\cdot}355 + 0{\cdot}00006\,t) \times t \times 36 =$	57·78 cals.
Heating Ca O to 3000 deg. $(11{\cdot}4 + 0{\cdot}001\,t) \times t =$	44·20 ,,
Decomposition of Ca O	145·00 ,,
Formation of CaC_2	0·65 ,,
	247·63 ,,
Formation of C O at 3000 deg. $(26100 + 2{\cdot}88\,t - 0{\cdot}0003\,t^2) =$	32·04 ,,
Heat required to form 64 grammes of calcium carbide	215·59 ,,

As 1 E.H.P.-hour equals 644·5 cals., this result may be given in more conventional form as follows:—

1 lb. CaC_2 requires { 1528·1 cals. / 2·37 E.H.P.-hours

1 E.H.P.-hour yields { 191·32 grammes / 0·422 lb.

In the paper to which reference has already been made, Gin allows for a loss of 10 per cent. in the current about the furnace, and a loss of about 11 per cent. in the energy between the prime motor and the dynamo conductors. In this way he gives the minimum effective horse-power as 6500 H.P.-hours per metric (?) ton of carbide. In practice, however, and as a result of his "repeated inspection of carbide factories," he takes 7000 H.P.-hours as the real working minimum. In a still more recent article, Liebetanz[16] states that 3·68 kilos. can be made per H.P.-day of twenty-four hours, and that therefore 272-H.P. are required at the furnace to yield 1000 kilos. per twenty-four hours. Liebetanz takes an efficiency of 75 per cent. in the electrical plant, and finally says that 450-H.P.—10,800 H.P.-hours—are needed per metric ton. Some time ago Worth announced that 1 E.H.P.-hour would give from 0·336 to 0·373 lb. of carbide; and if there be a loss of 25 per cent. in the energy between the motors and the furnace, 1 M.H.P.-hour should accordingly represent an average output of 0·267 lb. of carbide. Collating these results, and allowing for the smaller size of the continental horse-power, we have:—

	Effective H.P.-hours per long ton.
Gin	7,016
Liebetanz	10,825
Worth	8,390
Average	8,744

Since the theoretical yield works out to 5208 E.H.P.-hours per ton, the energy efficiency of the process is thus 59·6 per cent.; but allowing for the purely intermediate loss of 25 per cent., the theoretical yield corresponds to 6944 M.H.P.-hours, or a furnace efficiency of 79·4 per cent.

As regards the cost of the energy, estimates differ somewhat widely. Gin says that steam plant can be erected in France for about £10 per horse-power, that 5 per cent. for repairs and 10 per cent. for interest and depreciation should be allowed, so that the annual cost of steam power is roughly £3 per ton of carbide. He also says that the water plant at La Praz was erected for £7 10s. per horse-power, that at St. Felix for £5 3s. Water power, however, is much cheaper to maintain than steam power, and so he calculates the annual cost of the water energy at about 29s. per ton. Liebetanz[16] has taken the cost of water power at 30s. per H.P.-year, which corre-

[1] J. W. Richards, "Aluminium," third edition, 1896, page 239, *et seq.*

[2] In spite of the usual English practice, small calories are adopted throughout this calculation, because they are used by Richards himself; and their retention simplifies the reproduction and modification of his formulæ.

[3] *Journal* Chem. Soc. Abs., 1899, ii., 352. References are given to the abstracts in the *Journal* of the Chemical Society or to those in the *Journal* of the Society of Chemical Industry whenever possible instead of to the original memoirs, because the former periodicals are more accessible to English readers.

[4] *Journal* Chem. Soc. Abs., 1895, ii., 341.

[5] Richards, *loc. cit.*

[6] *Journal* Chem. Soc. Abs., 1896, ii., 8.

[7] Gin and Leleux. *Journal* Chem. Soc. Abs. 1898, ii., 323.

[8] *Journal* Chem. Soc. Abs. 1898, ii., 333

[9] Moissan. *Journal* Chem. Soc. Abs. 1899, ii., 154.

[10] Lewes. *Journal* Soc. Arts, 1898, xlvii., 123.

[11] Lewes, *loc. cit.*, page 121.

[12] "Zeitschrift für Calcium Carbid Fabrikation," 1899, iii., 128.

[13] "Gas Manufacture," second edition, 1898, page 376.

[14] Paper read before the Institution of Civil Engineers, March 15th, 1898.

[15] *Journal* Chem. Soc. Abs., 1893, ii., 444.

[16] *Journal* Chem. Soc. Ind., 1899, 318.

sponds, on the above figures, to about 36s. per ton. Lewes[17] has stated that water power costs nearly £4 per H.P.-year at Foyers, or about 97s. per ton of carbide—year of 7200 hours. Lunge[18] gives £11 or £12 as the cost of steam power in the industrial lowlands of Switzerland, and "not much above £1" for the cost of water power in the mountainous districts. At the last Budapest congress it would seem that some discussion took place on this subject and its bearings on the carbide industry, Liebetanz holding that in many situations calcium carbide might be made economically with coal-electricity, Gin upholding the idea that water must retain its monopoly. If 1 H.P.-year costs about £9 in England, and water costs even as much as £4, water is obviously cheaper and far better suited for a business where the energy bill is a relatively large item.

In his recent "Hurter Memorial Lecture," Lunge [18] has discussed at some length the relative merits of coal and water as stores of energy from the industrial point of view. He calls attention to the fact, as many authorities have done before, that the terrestrial stocks of coal which exist in civilised and manufacturing countries are being seriously encroached upon; that these stocks are finite in dimensions, and that they cannot be replenished. Paraphrasing his language, he hints that to burn coal is to live on one's capital, but to "harness" waterfalls is merely to utilise an "unearned increment" which hitherto has been almost neglected. To burn coal is not merely to pay an unnecessarily large sum for the energy required in any industrial operation, but it is also to hasten the day when coal shall no longer be available for any commercial process or even for domestic comfort. From whatever standpoint the question be approached, his insistence upon the desirability of abandoning the consumption of coal[19] whenever it can be compassed is absolutely unassailable; but his argument that this should be done because water power is cheaper seems open to economic attack. The question may at once be asked, are the prices mentioned above likely to be unaltered in the future? Is it worth while yet to invest huge sums of money on turbines, &c.—assuming the necessary waterfalls discoverable—simply because water power can be developed for a smaller outlay? If the coal measures of the world show signs of depletion, the cost of coal and steam power must eventually begin to rise; but in the meantime will water power remain at its present lower figure? There is little available water power in Great Britain, and, were it all harnessed, it would not prove a very serious competitor to coal as a source of energy; therefore the market for coal would not be much restricted; and therefore the cost of coal energy cannot be expected to fall even before exhaustion of the raw material causes it to rise. On the other hand, till within the past few years water power has only been played with in this country, being employed by millers who were content to work just when the river happened to be full, or in South Wales in the palmy days of the tin-plate industry, when the factories could afford to shut down in the summer.

It is a mere truism to remark that "power," pig iron, caustic soda, and the like, have no intrinsic value of themselves; they are not inherently necessary to mankind; they are but objects of barter for food; they are only worth "what they will fetch." If water power, even in lands where mountain torrents abound, is about to be systematically exploited as a rival to coal, the owners of trustworthy falls will quickly begin to think about the laws of supply and demand, and to take lessons in political economy. This will soon teach them that if water power can be almost as conveniently handled in manufacturing operations as coal has hitherto been, it must be an almost equally valuable asset; and they will naturally raise their demands for water-rights to a sum of sufficient magnitude to cause the expense of developing water energy to approximate closely to that of coal energy. Of course, if on striking the average over all civilised countries, the amount of available water power should be vast enough to control the market for power, it might also control—to some extent—the cost of coal, instead of the cost of coal controlling it; but even in this case—coal being the dearer—the two prices would approach one another, which means that the cost of water power should tend to rise. Coal has the inevitable advantage of infinite portability, for electrical current at present can only be transmitted a comparatively small distance; Lunge [18] reckoning that the economic radius of a Swiss waterfall is sixty miles, above which distance coal is cheaper again. Therefore, save in those localities where water is on the spot and coal many miles away, and perhaps also in those few exceptionally favoured places where both coal and water exist side by side, coal must always be more convenient than water, and as such must remain somewhat dearer than its rival; but until the coal measures are much nearer to their time of failure, the difference in cost should be more or less—according to the nature of the particular industry under consideration—neutralised by the cost of transporting the finished material from the uninhabited districts where waterfalls do mostly congregate to its final market amid the busy haunts of man. This line of argument is borne out by the statement recently made by Kershaw [20] that the H.P.-year generated at Zurich and Rheinfelden from water power costs more than it does under the best conditions in South Lancashire from coal; and also by the fact that much steam is still used in Switzerland in the immediate neighbourhood of water plant, though Switzerland is the very country which consists so largely of waterfalls.

Although it concerns the economist rather than the technologist to discuss this probable appreciation in the value of water power, it is not wholly beyond our jurisdiction to suggest that in the near future the cost of winning power from a fall of reasonable size and of known freedom from autumn failures shall only be a few shillings—possibly £1 or so when the manufactured product is very costly, or when the fall is at the uttermost ends of the earth—less than the cost of generating steam power in the same locality; the comparison being evidently made against the cheapest description of fuel burnt in the most modern variety of furnace or gas producer. And if this be the case, English estimates of the manufacturing costs of articles made by water power in which the latter is taken at anything much below £6 or £8 per H.P.-year can only remain correct for a short period, and should always be received with suspicion.

It is practically impossible to give a fair estimate of the total cost of making calcium carbide in this country, because the price of the lime and coke must depend almost entirely upon the situation of the proposed works; but as these factors can easily be determined by anyone interested in the matter, a couple of similar estimates lately published by Ludwig[21] may be not altogether devoid of value. In the first case he deals with a factory of 1600-H.P. producing about 1600 metric tons of carbide per year:—

I.—*Factory of* 1600 *Effective Horse-power.*

	£
Capital expense—	
Generators	3350
Switchboards and conductors	600
Furnaces and electrodes	1500
Various plant	1150
Crusher for coke, &c.	600
Sundries and patent licence	2000
	£9200

Annual expenditure per ton of carbide—	Shillings.	
700 kilos. of coke at 25s. per 1000	17·50	
1100 kilos. of lime at 15s. per 1000	16·50	
20 kilos. of electrodes at 350s. per 1000	7·00	
		41·00
Salaries and wages: Manager £350, foreman £100, 29 employés, £90—£35		19·14
Office expenses, sundries, and lubricants (!)		8·00
Maintenance and depreciation, 10 per cent. on £9200		11·50
Unforeseen expenses		15·00
		94·64

(Say, £5 per ton, exclusive of actual buildings and power.)

II.—*Factory of* 3000 *Effective H.P.*

Annual expenditure—	Total. £	Per ton. Shillings.
Inclusive cost of power, buildings, &c.	4250	31·67
Salaries and wages	2500	16·67
Various: Office, insurance, unforeseen, and lubricants	3000	20·00
Maintenance and depreciation: 10 per cent. on dynamos, motors, and furnaces, 2 or 3 per cent. on buildings, turbines, &c.	5500	36·67
Materials—		
900 kilos. of lime at 11s.		9·90
600 kilos. of coke at 30s.		18·00
Electrodes		15·00
Packing		80·00
		72·90
		177·91

(Say, £8 18s. per ton, everything included.)

LITERATURE.

Heat and Heat Engines: A Study of the Principles which underlie the Mechanical Engineering of a Power Plant. By Fred. Remsen Hutton, E.M., Ph.D., Professor Mechanical Engineering at Columbia University. Published by John Wiley and Sons. 1899

This is a ponderous volume of 550 pages and many diagrammatic illustrations and tables, in which a sincere and persistent endeavour is made to bring home in an intimate fashion to practising engineers the science of the generation of power by heat. Towards any such endeavour engineers ought to manifest sympathy and respect, remembering that even at this late date only a very roughly approximate correspondence has as yet been established between practice and the teachings of science. Probably any effort such as is made in this book would, under existing conditions, and perhaps unavoidably, display defects as well as merits, as does certainly this work of Professor Hutton's; but any endeavour to lay bare the roots of the subject with the laborious conscientiousness and ready impartiality that runs through the whole volume cannot fail to do much to advance the cause the author has at heart. The thoroughness and patience with which he has thought over and through the subject in its length, and breadth, and depth, is illustrated by the frequent long numbered classifications of the branches of each section of it, and of the pros and cons of each element of practice. Thus, in twenty-three chapters he works through an eleven-fold classification of the whole; his classification of solid fuels is eight-fold, with subdivisions; he enumerates seventeen advantages and nine disadvantages of oil fuels; he tells off ten reasons for the non-attainment of the theoretical heating efficiency in the use of fuels; he numbers seven advantages and three disadvantages of artificial draught; he has a list of seven methods of smoke-prevention; the benefits of multiple expansion in double, triple, and quadruple-cylinder engines are numbered up to thirteen, and their defects up to eight; his "deductions from the temperature-entropy diagram" are numbered up to ten, and the "elements of departure of the actual from the ideal cycle" up to eighteen; but, not satisfied with this, he re-classifies the sources of loss of heat twice more, each classification running to seven headings; he subjects the steam-jacket to eight "comments;" he comes back to the temperature-entropy diagram and analyses its use into nine different "steps," and the "losses revealed" by it into nine items. Internal combustion engines, vapour engines, mechanical refrigeration, and the injector, are similarly dealt with. For the logical examination of a complicated subject, no doubt this systematic method of numerical analysis is strictly the most scientific, but we must confess that the plodding through 500 large pages of it for the purpose of review on a standard of conscientiousness equal to Professor Hutton's is apt to make the effete brain of this side the Atlantic reel with dizziness, and we are inclined to suggest that some of these lists might be usefully shortened by the excision of tautological repetitions. The numerous and extensive tables throughout the book, giving physical data respecting the materials to be used, are an excellent feature of it. Their compilation represents a vast amount of labour, and the experimental numbers given appear to be throughout authentic and trustworthy. We would especially mention those relating to solid, liquid, and gaseous fuels, which are very complete, but, indeed, of every substance involved in power production from heat full tables of physical "properties" are given. The "steam property" table follows the sensible method of advancing by steps of 1 lb., 5 lb., 10 lb., and 50 lb. per square inch, instead of the silly method common in our own English books of advancing by steps of 9 deg. Fah. temperature. Nothing could be more inconvenient for interpolation than this 9 deg. step, and it is a pure result of laziness—avoidance of the trouble of converting from Regnault's original steps of 5 deg. and 10 deg. Cent. It is a real pity that Professor Hutton, so conscientiously laborious in other things, has not set out many of these tables in diagram form as curves on squared paper. The reason may be that on such a diagram he cannot get his decimal fractions in with exactitude. Our American friends believe greatly in the effectiveness of long rows of figures, and do not pause to consider what relation is borne by the exactitude of such numbers to the exactitude of the actual physical knowledge they profess to express. They express by a 5 or 6 figure number a result determined by physical tests subject to error sometimes of several per cent. Thus, Professor Hutton gives the heating power of "petroleum refuse" as 19,832 Br. heat units, and its theoretical evaporative power per lb. as 20·53 lbs. of water. He gives to the mean of "good English coal" the corresponding numbers 14,112 and 14·61 He states the weight of "water vapour" theoretically producible from the combustion of 1 lb. of marsh gas as 21,592·8 lb., and the heat units in 1000 cubic feet of "producer gas" as 156,917. The heat units in "naphtha gas," "after deducting 25 per cent. loss." are 229,774; and the energy in the gas produced from 100 lb. of anthracite is 1,157,304 heat units, calculated from the following assumptions:—(1) 85 per cent. solid carbon in the anthracite stock; (2) 5 per cent. volatile hydrocarbons; (3) 10 per cent. ash; (4) 8 per cent. of carbon burnt to CO; (5) 5 per cent. of carbon burnt to CO_2. Considering the character of these very fair and reasonable "assumptions" and "deductions for loss," the significance of the last four or five figures in each of these last two numbers is hard to recognise; but the exactitude of the previous numbers is no less extravagantly absurd when one thinks of the degree of exactitude indicated in such phrases as "petroleum refuse," et cetera. These are no isolated instances, but are taken at random from masses of similar figures given by Professor Hutton. What amount of eye-strain might he have saved to his conscientious reviewers by omitting all these unmeaning figures? The saving might be expressed in six-figure numbers, but we would thankfully accept zeros, for the last five if the first gave a fair measure of the fatigue.

Irrespective of the way in which they are figured out, his methods are usually of much practical worth. For instance, few, if any, other books go into so much detail in calculations of weight and volume of air required for combustion, which are of much more practical moment than correspond with the trouble or absence of trouble commonly spent on investigation of the matter. Again, his lists of the manifold considerations that affect each step in the design and action of a steam-power plant ought to leave the mind impressed with the folly of expecting any but a very small percentage of the total result to be deducible from so exquisitely elegant and facetiously simple a formula as $\frac{T_1 - T_2}{T_1}$. The child-like blandness of this seductive legend, $\frac{T_1 - T_2}{T_1}$, ought not to blind a wary American to the evident fundamental kinship of character and method between the Cambridge mathematician and the heathen Chinee. But Professor Hutton, after straining nerve and muscle to see all round, to feel over the top and dig under the foundations, to peer up the sleeve, to use stethoscope and ophthalmoscope to measure the hidden workings of the interior, yet always comes weakly and illogically back to the attitude of the reverent baby, who must accept as literal gospel truth everything that his grandfathers, or, as he terms them, the "master thinkers," have put into the shape of a formula. The men he refers to were, indeed, master thinkers, and will always be remembered as such; but if they had been thinking and watching all the time since they first gave the public the benefit of their thoughts in the shape of algebraic formulæ, their despair at the manner in which their thoughts have been misinterpreted and misreported would probably make them repent having ever made use of that mode of expressing themselves. Thus the blandly seductive formula above quoted leads Professor Hutton, as it has led many another man, to state that the availability for the production of mechanical power of the heat put into a "medium" depends upon the "lowest temperature of surrounding objects." Now Professor Hutton writes a chapter of twenty-five pages on "Compressed-air Engines," and another of thirty pages on "Mechanical Refrigeration," and he knows, as well as every other engineer who has ever had anything to do with air engines, that the temperature of the exhaust from them gives frequent trouble from being immensely below the "lowest temperature of surrounding objects;" that it, in fact, gathers ice in the

[17] *Journal* of the Society of Arts, 1898, xlvii., 120.
[18] *Journal* of the Society of Chem. Ind., 1899, 895, October.
[19] The word "coal" is used for simplicity; the expression must be understood to include wood, brown coal, lignite, peat, &c.—anything that can be burnt.
[20] *Electrical Review* October 20th 1899.
[21] Zeits. Calciumcarbid Fabrik, 1899, iii., 198.

exhaust ports if there be any moisture in the air, while all "surrounding objects" evidence no tendency whatever towards the formation of ice upon their surfaces. Here then is a case in which it is known to every one with an elementary acquaintance with the facts of mechanical practice, that "the temperature of surrounding objects" has absolutely nothing to do with the lower working limit of an engine which quite distinctly is a thermodynamic engine, or may, in respect of the exhaust, be treated as such. The compressed-air engine is usually made quite clearly a thermodynamic engine by the preliminary heating of the air as it passes from the air-main to the engine, but, even without this it may with strictness be treated as a heat engine. Moreover, refrigerating engines are precisely on all fours with these, and they are, of course, always treated as heat engines. In both, the lower limits imposed upon the working are incontestably pressure limits—the lowest pressure that can be obtained in surrounding objects. But a single exception breaks down the universality of a law, while the pretension set up for the law we are discussing is that it is a fundamental and universal principle governing the whole science of thermodynamics. The law expressed algebraically by $\frac{T_1 - T_2}{T_1}$ is, when properly interpreted and properly applied, of course, exactly true; it is the wild and indiscriminate application of it to the practical limits imposed upon the working of engines to which we entirely object.

The Strength of Materials. By J. A. EWING, M.A., B.Sc., F.R.S., M. Inst. C.E. Cambridge: University Press. 1899.

THIS is a somewhat didactic book, excellently written and full of pretty mathematics. The mathematics are in an easy and elegant style, although they seem not always to follow the straightest path to the result aimed at. The portions devoted to description of physical phenonomena are very thoroughly modern, papers published during the current year being not infrequently quoted. So far as guidance in applying scientific physical truth to practice is concerned, the book does not contain much of direct value. For instance, the question of "factors of safety" is finished off in one and a-half pages. It defines the factor as the ratio of ultimate to working stress, and entirely ignores the controversies as to whether it should be applied to loads, stresses, or sections; whether it is best referred to the limiting elastic stress or to the breaking stress; how it is to be applied to periodically varying load, &c. Again, it passes over in silence the difficult but practically important subject of hammer-blow stresses, on which question an acute mathematician and skilful physical investigator ought to be able to throw much useful light. In the midst of much most interesting discussion of the many treatments which change the strength and modulus of elasticity in metal, the effects upon the latter of hardening and tempering tool and spring steel appear to have been wholly forgotten, although surely it is the most important branch of the whole subject. It is well known that spring makers, when required to produce springs of exact specified elasticity, make the adjustment in the tempering process. On the subject of overstraining, hardening effect of rest, recovery of strength by annealing, and of elasticity by low heating, much valuable information is given; and the subject of stress-strain hysteresis is explained in outline, although the connection of this latter with "fatigue" is not expounded in any clear manner. It is suggested that loss of energy and fatigue naturally go together, but no attempt is made to explain the *modus operandi* of the connection. Regarding the passage from the elastic to the semi-plastic condition an important note is, "The breakdown of the (molecular) structure appears to communicate itself gradually from place to place along the bar" in the testing machine. The connection between this and the time-effects in semi-plastic yielding is obvious. Professor Ewing also states that it is proved "that normal pull diminishes resistance to shearing and normal push increases resistance to shearing." Here he means by "shearing," actual fracture by shear; and this difference between the effects of tension and compression when combined with tangential stress is easily explainable by reference to what may be spoken of as internal frictional or abrasive resistance. There is a chapter on testing machines, which, however, is practically confined to the form of machine sold by Buckton and Co., and to the extensometers of the author's design. It might be extended with advantage. To the numerical results of testing various materials five pages only of text and a very academic appendix of three pages. are devoted. This also might advantageously be very much enlarged. To devote five pages only out of 240 to the numerical data of the whole subject of the volume hardly seems to be doing justice to actuality. Extensometer measurements of elasticity in two steels, one "much milder than the other," are quoted without specifying either the amount of carbon or the temper. It is fair to note that they are quoted specially for the purpose of showing that the carbon percentage has little effect upon the modulus of elasticity. The variations of the effects upon strength and elasticity of quenching from red heat with gradually increasing carbon percentage are most interesting and commercially important, but are here referred to only in very vague terms; and no references are made to the enormously important investigations recently made by the Institution of Mechanical Engineers' Committee on Alloys.

As already stated, the mathematics of the book are extremely elegant. The first two chapters, dealing with fundamental explanations, are a model of simplicity; but the relations between the elastic constants are not tabulated or brought together in any clear manner. A diagram showing these relations by help of two or three curves would be a useful addition. On page 98 is an instructive discussion of the circumstances under which the symmetrical central loading of a section does not produce uniform distribution of stress. It is pointed out that such non-uniformity of stress occurs mainly at places near sudden or rapid changes of sectional size, and also that, as sections are taken receding from such points of change of size, an approach to uniformity of normal stress is brought about by the operation of sheer stress; but it would have been decidedly useful to add that the distance within which any given degree of approximation to uniformity is reached is inversely proportional to the modulus of rigidity. The contrary is apparently suggested in the paragraph at the foot of the page. At page 107 a clear explanation of the general character of the difference in beam-bending within and beyond the elastic limit is given; but again we are rather inclined to complain of the omission of any statement of the manner or of the amount of the corresponding change in the formula for bending strength moment.

There is a great difference between elegant and logically correct mathematical development of results, on the one hand, and making sure of your physical data on the other. The former is useful, but the latter is more important. Prof. Ewing states that a bending moment upon a beam section produces normal stress that varies uniformly across the section, but he gives no reason for believing this to be the case. It would be easy to recognise that it must be so if the cross sections truly flat before bending remained truly flat after bending; but as these sections are, as a matter of fact, distorted by shear strain varying across the section according to a somewhat complicated law, it becomes important to show whether, under any circumstances, this distortion interferes to a material degree with the hypothesis of uniformly varying normal stress. For example, where the section of the beam changes suddenly, there are actually on two neighbouring sections very different distributions of shear strain. Is the effect of such sudden variation of section upon the bending strength as dependent upon normal stress not well worth narrow examination?

The graphic treatment of moments in continuous girders, and also of pin-joint frames, and the theory of struts, are not given the completeness that one would expect; but the subsequent sections on torsion shafts and on thick cylinders and shells are in every way excellent. Stresses in revolving rings and discs are treated in the same place, as the same mathematical forms apply to the two problems.

The book is worthy of Professor Ewing's reputation as an acute and accurate mathematician, and as a skilled investigator in the physical laboratory, and is decidedly an important addition to our technical literature, although it omits to deal with some branches of the subject in nearly so great detail as is attained in the best German text-books.

SHORT NOTICES.

Monthly Star Maps for the Year 1900: With Notes on the Luni-Solar Calendar and the Incidence of Easter; together with an Explanation of Certain Unusual Occurrences in the Calendar for 1900. By Walter B. Blaikie. Second edition. The Scottish Provident Institution. 1900.—The idea and arrangement of this volume are excellent, and the execution is all that can be desired. The size of the pages is 11in. by 8½in. On twelve of them, one for each month, are given two semicircular charts of the heavens, one of the northern, the other of the southern aspect. These semicircles are filled in with blue, on which the various stars are printed in gold, some idea of their magnitudes being given by the size. The names of all the constellations are given, and also of the principal stars, and the course of several planets and the moon through the sky is also marked. These maps have been calculated for the latitude of London, and the scene of the outlook is from Westminster Bridge at 10 p.m. on the first of each month. Besides the maps there is a brief calendar, with astronomical notes and other features, which are mentioned on the title page. The whole forms a most interesting book, and should be of great use to all who take interest in things celestial.

Electric Lamps and Electric Lighting: A Course of Four Lectures on Electric Illumination, delivered at the Royal Institution of Great Britain. By J. A. Fleming, M.A., D.Sc., F.R.S. London: The *Electrician* Printing and Publishing Company, Limited. 1899.—This is a second edition, which is published in a new and cheaper form than that of the original. The lectures which form the basis of the book were delivered in 1894, but it is very evident that the lectures have been largely added to, for their length, as they appear in book form, would prohibit their being read in an hour. They are intended for general, non-technical readers, and it is sought to give such explanations of the physical effects and problems concerned in modern applications of electricity for illuminating purposes as might serve to further an intelligent interest in the subject, and perhaps pave the way for a more serious study of it. We notice that in nearly every detail the book has been brought well up to date. It is illustrated, but many of the cuts—especially the tone cuts—are bad, and might well have been left out.

The Workmen's Compensation Act, 1897: Being a Digest of Cases tried in the Court of Appeal; with an Introductory Chapter on the Act. By William E. Hughes, B.A., and H. Greville Montgomery. London: 43, Essex-street, Strand. 1899. Price 2s. 6d. net.—This is intended to be a practical guide to the Workmen's Compensation Act, 1897, for the use of busy practitioners and to employers of labour. It is proposed in the future to add to it by preparing a digest, at the end of each session, of the cases which have gone to the Court of Appeal during that period. In its present form the book embodies a short summary of the Act, in which attention is drawn to the salient features of this statute. Then follows a digest of all the cases which have gone to the Court of Appeal. The special point involved in each case is set out in as few words as possible, with the decision of the Court. At the end of the book—which will without doubt be found useful—there is given the text of the Compensation Act, together with the Factory and Workshop Acts and the Workmen's Compensation Rules.

Discoveries and Inventions of the Nineteenth Century. By Robt. Routledge, B.Sc. Thirteenth edition, revised and partly re-written, with additions. Containing 456 illustrations. London: George Routledge and Sons, Limited. 1900. Price 7s. 6d.—As a popular encyclopædia of the engineering and scientific progress of the present century, this volume is in a very large measure a success. It fails just at the point where all encyclopædias fail—that is, that much of it is out of date. Much revision has been made by Mr. Routledge, and much new matter added, but in many respects the book is antiquated. Still, when the low price of the volume is considered, we must not complain that it is not all re-written and re-illustrated, and we must in fairness admit that, as far as it goes, it is an excellent popular history of the discoveries and inventions of the present century.

Pyramids and Progress: Sketches from Egypt. By John Ward, F.S.A. With an introduction by the Rev. Professor Sayce, D.D., LL.D., &c. London: Eyre and Spottiswoode. 1900. Price 7s. 6d. net.—To all who are under the charm which antiquity exercises, to all lovers of things ancient, to all students of Egyptian lore, this book will be welcome. The engineer will find in it, too, many passages which will afford him food for reflection, and will get pleasure and instruction from reading Mr. Ward's account of the great irrigation works now in course of erection, and not a few will sympathise with his regrets that the beautiful island of Philae must be drowned, whilst fully appreciating with him the necessity for the sacrifice.

Hydraulic Diagrams for the Discharge of Conduits and Canals: Based upon the Formula of Ganguillet and Kutter. By Chas. H. Swan and Theodore Horton. With a description of the diagrams and their use, by Theodore Horton. New York: The *Engineering News* Publishing Company. 1899.—This set of sixteen diagrams refers to diagrams of eight different forms of cross sections of conduits, such as are in general use for sewage and water supply, and to canals of rectangular and trapezoidal cross section. The size of diagrams is 6in. by 4in. and 4in. by 3in., but the scale and squaring in all cases appear to be very accurate and sufficiently clear for any ordinary work.

Railway and Timber Trades' Measurer and Calculator. By M. B. Cotsworth, Holgate, York. Second and revised edition. London: McCorquodale and Co., Limited, and of the Author. Price 3s. 6d.—This is a new edition of a set of tables which have gained considerable popularity. It contains general instructions for the measurement of timber, stone, &c., and illustrative examples of the use of the tables are given. It is clearly printed, and made up in a long form, which is at once handy for the pocket and convenient for tabulation.

BOOKS RECEIVED.

The Railway Almanack, 1900. Price 6d. London: McCorquodale and Co., Limited.

The Railway Diary and Officials' Directory, 1900. Price 1s. London: McCorquodale and Co., Limited.

The Advance of Knowledge. By W. Sedgwick, Lieut.-Colonel late Royal Engineers. London: George Allen. 1899. Price 6s.

The Modern Safety Bicycle. By H. A. Garratt. With 104 illustrations and five working drawings. London: Whittaker and Co. 1899. Price 3s.

Decorated Wood-work; by Carving, Colouring, and Wire Inlaying. By Chas. Godfrey Leland. London: Dawbarn and Ward, Limited. Price 6d. net.

On the Prevention of Eye Accidents occurring in Trades. By Dr. Simeon Snell, F.R.C.S. Edin. London: John Bale, Sons, and Danielsson, Limited. 1899. Price 1s. net.

Les Moteurs à Explosion, étude a l'usage des Constructeurs et Conducteurs d'Automobiles. Par George Moreau. Paris: Librairie Polytechnique. Ch. Béranger, editeur. 1900.

Dyes, Stains, Inks, Varnishes, Polishes, &c.: How to Make and Use Them. By T. Bolas, F.C.S., F.I.C. "Useful Arts and Handicrafts Series," No. 4. Dawbarn and Ward, Limited. London: 1899.

Picture Frames by Novel Methods. By Charles G. Leland and Thomas Bolas. Being No. 3 of "Useful Handicraft Series." Edited by H. Snowden Ward. London: Dawbarn and Ward, Limited. Price 6d. net.

A Hand-book of Highway Cases Noted in "The Surveyor and Municipal and County Engineer." Carefully revised and corrected. By J. B. Reignier Conder. London: The St. Bride's Press, Limited. Price 2s. 6d. net.

Electric Lamps and Electric Lighting: A Course of Four Lectures on Electric Illumination delivered at the Royal Institution of Great Britain. By J. A. Fleming, M.A., D.Sc., F.R.S. London: The *Electrician* Printing and Publishing Company, Limited. 1899. Price 6s. net.

Every Man's Own Lawyer: A Handy Book of the Principles of Law and Equity. By a Barrister. 37th edition, carefully revised including the Legislation of 1899, to which is added a concise dictionary of legal terms. London: Crosby Lockwood and Son. 1900. Price 6s. 6d.

Lord Kelvin, Professor of Natural Philosophy in the University of Glasgow, 1846-1899: With an Essay on his Scientific Works. By George F. Fitzgerald, Trinity College, Dublin, and an account of the celebrations on the occasion of Lord Kelvin's Jubilee as a Professor. Glasgow: James MacLehose and Sons. 1899.

CATALOGUES.

Bayley's, Limited, Newington Causeway, London.—Steam motor vans.

Louis Harper, Aberdeen.—Harper's steel ropes suspension bridges. Illustrated price list.

Buck and Hickman, Whitechapel-road, London.—The 1900 tools and machinery catalogue issued by this firm is a handsome book of 500 pages. The book is copiously illustrated, and well indexed.

British Thomson-Houston Company, Limited, Cannon-street, London.—Illustrated description of the O.K. ampère-hour meter. This new type of meter is constructed for use on continuous-current circuits only, and for capacities of three ampères and under.

G. M. Callender and Co., Victoria-street, Westminster.—Callender's pure bitumen sheeting. This pamphlet is a reprint from a contemporary, and contains an illustrated description of the process of lining a reservoir near Whitby, by Mr. G. B. Williams, A.M. Inst. C.E.

The United Asbestos Company, Limited, Billiter-street, London.—This catalogue is an excellent example of the printer's craft. In it the whole of the various branches of the company's work are brought together for the first time. They embrace asbestos goods, rubber manufactures for mechanical purposes, lubricants, boiler and pipe coverings, and engineers' sundries. The book is of handy size, and is well indexed.

The British Westinghouse Electric and Manufacturing Company, Limited.—Circular No. 1000, polyphase induction motors, type C2, for constant speed. Circular No. 1001, belt-driven railway generators. Circular No. 1002, generators and rotary converters for electrolytic work. Circular No. 1003, direct-current engine-type generators, 125 volts. Circular No. 1004, direct-current engine-type generators, 250 volts.

ALUMINIUM CABLES.—The feeders of the new North-Western Electric Elevated Railroad, in Chicago—which is the fourth railway of this kind in the city—will be 1½in. aluminium cables, about twenty miles of these cables, weighing 150,000 lb., having been ordered. Aluminium is cheaper, and although of less conductivity than copper, yet with the same weight a considerably greater conductivity can be obtained. The cable will be carried by insulators on the transverse girders which carry the longitudinal girders of the structure. The National Electrolytic Company, of Niagara, obtains its current from the electric plant at the Falls by a cable made of ¼in. aluminium strands. Aluminium telephone wire for twenty-five miles has been sent to Manila; thirty-two miles of aluminium cable have been sent to an electric light company at Hartford, and seven miles of aluminium cable for power transmission have been ordered for Brazil.

THE LIPPINCOTT PLANIMETER.

By Professor A. G. GREENHILL.

THIS instrument is a modification of the Hine-Robertson planimeter, and it is brought out by the same inventor, Mr. A. C. Lippincott, with a view of performing the more extended class of work required now of a planimeter, and not merely of running out the area of a steam engine indicator diagram. The two arms are made as usual—Fig. 1—but whereas in the ordinary Amsler

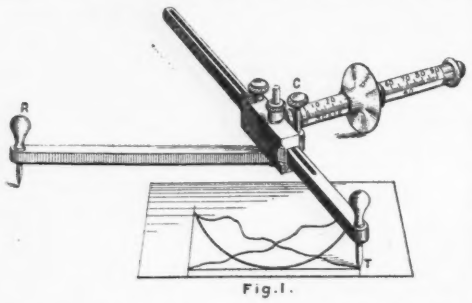


Fig. 1.

planimeter the record of the area is made by the rolling of a wheel, and the side-long drag or side-slip of the wheel over the paper is ignored, in this instrument these conditions are reversed; the rolling of the wheel is ignored in Mr. Lippincott's invention, and it is the side-long movement of the wheel on the graduated bar—Fig. 3—which gives the record of the area to be

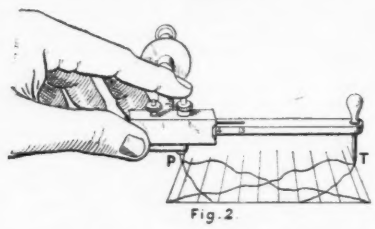


Fig. 2

measured. The side-long movement of the wheel takes place up and down the bar carrying the graduated scale—Figs. 1 and 2—and thereby all dragging or scraping of the wheel over the paper is avoided; the motion of the wheel is pure rolling, the edge of the wheel being made sharp enough to prevent a side-slip, and thereby a smooth and regular motion over the paper is secured.

No alteration of shape in the wheel or injury of the knife edge of its periphery has any effect on the accuracy of the reading. This is an important advantage in comparison with those instruments where the edge of the wheel is extremely delicate, and will not bear the slightest injury or spot of rust. The instrument is used in the same manner as the ordinary planimeter, the resultant travel of the wheel along the scale being read off after the contour of the area has been completed by the trac-

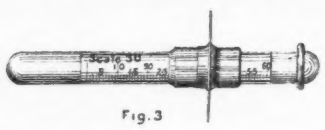


Fig. 3

ing point T, and thereby the area is given in any desired unit. For greater accuracy the readings may be taken on both sides of the wheel, and the mean taken. In the Amsler planimeter an increased accuracy of reading is obtainable by going round the contour a number of times, and taking the average by dividing by the number of circuits. This is not possible with the present instrument, but the same accuracy of multiple readings is obtainable by going round the contour alternately one way and the other, and then averaging the readings. The bar carrying the wheel is made of a glass tube, with the scales marked on a piece of card sealed up inside, to preserve the scales from damp and injury. Three of these scale tubes are provided with the instrument, each provided with two different graduations, so that the mean effective pressure in an indicator diagram may be

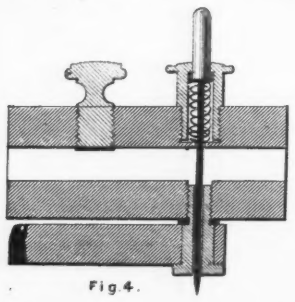


Fig. 4.

read directly without computation, for the indicator springs 6, 8, 10, 12, 16, 20, 24, 30, 32, 40, 50, 60, 80, 100, 120, and 150. For instance, if it is required to ascertain the mean effective pressure of a card taken with an 80 spring, insert a tube containing a forty scale and mentally double the reading; or, if special accuracy is required, trace the diagram twice without stopping, and the reading will be correct for an 80 lb. spring. In this manner the six scales supplied can be made to suit all practical purposes. If an area is to be read off in square inches, use a forty scale and set the points P and T 4in. apart, as in Fig. 15. The points may be set 5in. apart and a fifty scale used, or 6in. apart with a sixty scale, and so on for larger areas.

A neat arrangement for setting the instrument to any desired scale of measurement is shown in Fig. 4, by means of which the point P is ordinarily drawn out of sight by a spring, but P can be pressed out when it is

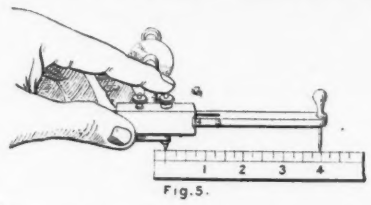


Fig. 5.

required to set the two points P and T at any required distance—Fig. 2. In this way the accuracy of the instrument is not impaired by any moderate bending of the point T.

To use the instrument for reading an indicator diagram—Fig. 6—select the tube containing a scale corresponding to the spring in the indicator, insert the glass tube in the clamp C, after which the clamp screw is to be tightened enough to prevent the tube from being moved easily. Loosen the set screw S, and adjust the points P and T to the proper distance, the length of stroke on the indicator card, as shown in Fig. 2; the set screw should then be firmly tightened, so that the tracer bar cannot be moved in the frame block. After fastening the card on the table with drawing pins, place the instrument as in Fig. 6, with the radial R P arm at right angles to the tracer arm P T, and set the left-hand edge of the wheel at zero on the scale, with the tracer point at the corner B of the diagram. The point T should trace the contour in the clockwise direction, care being taken that the wheel does not strike at either end of the glass tube in making the circuit.

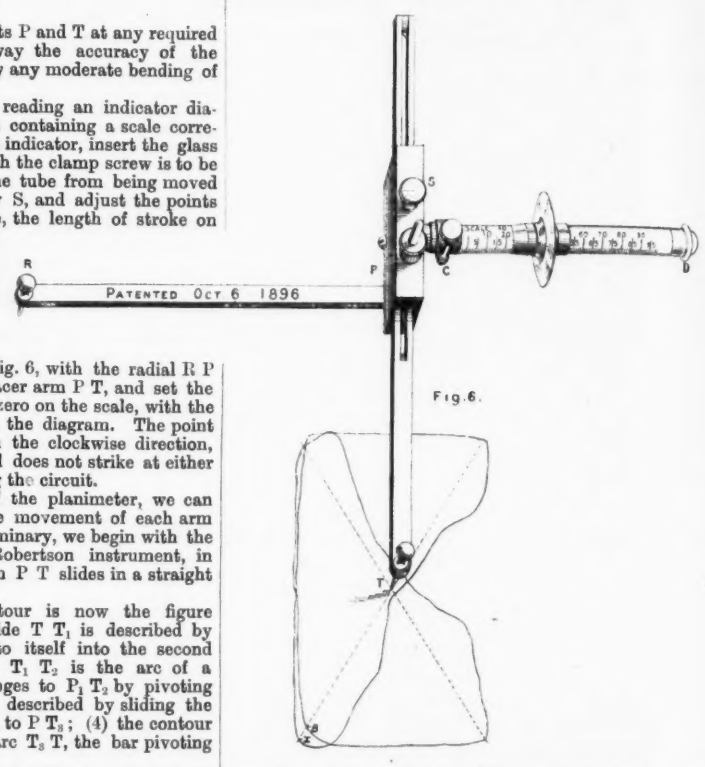


Fig. 6.

In explaining the theory of the planimeter, we can analyse the reading due to the movement of each arm one at a time; and, as a preliminary, we begin with the theory of the former Hine-Robertson instrument, in which the point P of the arm P T slides in a straight slot A B—Fig. 7.

The elementary finite contour is now the figure $T\ T_1\ T_2\ T_3$, in which (1) the side $T\ T_1$ is described by sliding the bar P T parallel to itself into the second position $P_1\ T_1$; (2) the side $T_1\ T_2$ is the arc of a circle described as $P_1\ T_1$, changes to $P_1\ T_2$ by pivoting about P_1; (3) the side $T_2\ T_3$ is described by sliding the bar parallel to itself from $P_1\ T_2$ to $P\ T_3$; (4) the contour is completed by the circular arc $T_3\ T$, the bar pivoting round P from $P\ T_3$ to P T.

We have now to prove that the finite area $T\ T_1\ T_2\ T_3$ is equal to a rectangle, whose base is the length P T, and height is the travel of the wheel on the graduated arm C D. Supposing the wheel is initially at W—Fig. 8—(1) is the movement of P T parallel to itself to $P_1\ T_1$, the wheel rolls on the paper in a straight line perpendicular to C D to W_1, and thus advances on the graduated bar

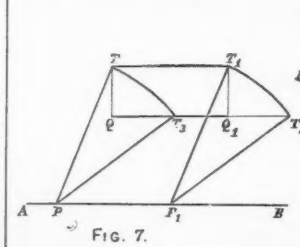


FIG. 7.

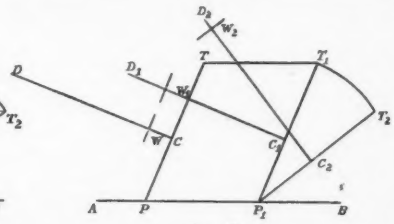


FIG. 8.

a distance $w\ W_1$; and the area of the parallelogram $P\ T\ T_1\ P_1$ is equal to a rectangle whose base is P T and height $w\ W_1$; thus the travel of the wheel in this movement records the area $P\ T\ T_1\ P_1$. Pivoting the bar $P_1\ T_1$ about P_1—Fig. 8—(2) in the movement of $P_1\ T_1$ into the position $P_1\ T_2$, the wheel moves from W_1 to W_2 on the involute of the circle $C_1\ C_2$; the wheel thus moves on the bar an extra distance $w_1\ W_2$ equal to the arc $C_1\ C_2$.

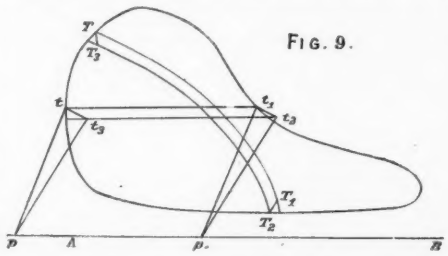


FIG. 9.

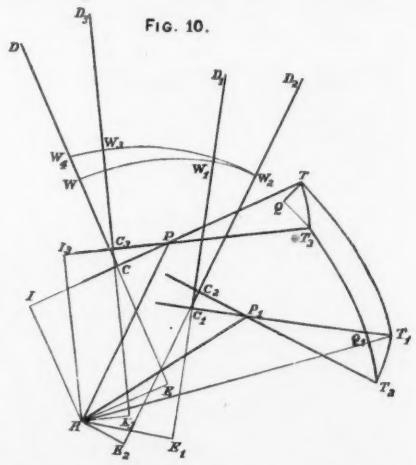
(3) Sliding $P_1\ T_2$ parallel to itself into the position $P\ T_3$ makes the wheel recede on the bar through a distance which, as in the first movement, records the area of the parallelogram $P\ T_3\ T_2\ P_1$. (4) Pivoting the bar about P so as to bring $P\ T_3$ back to its initial position P T makes the wheel, as in the second movement, recede along the bar a distance C C_2 or $C_1\ C_2$. The second and fourth movements of the wheel thus cancel; so that the total advance of the wheel along the graduated bar C D, which is the resultant difference of the first and third movements, registers the difference of the parallelograms $P\ T\ T_1\ P_1$ and $P_1\ T_2\ T_3\ P$, or the parallelogram $Q\ T\ T_1\ Q_1$, which is the area of the contour $T\ T_1\ T_2\ T_3$, the areas $T\ Q\ T_3$ and $T_1\ Q_1\ T_2$ being equal in all respects. Thus the total travel of the wheel, multiplied by the length P T, gives the area of the finite contour $T\ T_1\ T_2\ T_3$.

Any complicated area, such as an indicator diagram—Fig. 9—may be supposed dissected into a large number of small elementary contours $t\ t_1\ t_2\ t_3$ of the same nature as the finite contour $T\ T_1\ T_2\ T_3$, and the reading of the wheel when the outside contour is described will be the same as if the point T was carried round all the elementary contours successively and in the same direction. The internal lines being traversed twice in opposite directions, leave no trace in the movement of the wheel, so that the reading when the contour is described will give the area enclosed by the contour.

Next in the theory of the new Lippincott planimeter, composed of the two arms R P and P T, in which the point R in Fig. 1 is fixed, and P describes a circular arc $P\ P_1$ round the centre R, while the arm P T is pivoted at P and T describes a circle relatively to P, the elementary contour due to the movements one at a time of the pivots at R and P will be $T\ T_1\ T_2\ T_3$, in which $T\ T_1$ and $T_2\ T_3$ are arcs of circles round R as centre, while $T_1\ T$ and $T_1\ T_2$ will be arcs of circles round centres P and P_1 respectively—Fig. 10. (1) As T moves to T_1, the wheel W moves on the graduated bar to W_1 in such a manner that the wheel rolls on the paper along an involute of the circle $E\ E_1$, where E and E_1 are the feet of the perpendiculars from R on the graduated bar in its first and last position; and thus the travel of the wheel along the bar C D, $w\ W_1$ = arc $E\ E_1$. (2) As T_1 moves to T_2 by the movement of the pivot P_1 the wheel rolls on the paper from W_1 to W_2, and advances along the graduated bar a distance equal to $C_1\ C_2$.

(3) From T_2 to T_3 the wheel rolls on the paper from W_2 to W_3 on the involute of the circle $E_2\ E_3$, and recedes along the graduated bar a distance equal to the arc $E_2\ E_3$.

FIG. 10.



(4) From T_3 to T_1 in completion of the circuit $T\ T_1\ T_2\ T_3$, the wheel moves W_3 to W_4 along the involute of the circle $C_3\ C$, and recedes along the graduated bar a distance equal to the arc $C_3\ C$. The distances $C_1\ C_2$ and

C_3 C are equal, and thus the travel given in movements (2) and (4) cancels; the resultant travel of the wheel along the graduated bar C D is thus the difference of the arcs E E_1 and E_2 E_3, or (R E_1 − R E_2) δ, where δ denotes the radians in any one of the equal angles T R T_1, T_2 R T_3, E R E_1, E_2 R E_3.

The area of the contour T T_1 T_2 T_3 is the difference of the sectors R T T_1 and R T_2 T_3, and is therefore

$$\frac{1}{2}(R T^2 - R T_3^2)\,\delta.$$

But if R I_1, R I_3 are the perpendiculars from R on P T, P T_3, then

$$R T^2 = R P^2 + P T^2 + 2 I P . P T,$$
$$R T_3^2 = R P^2 + P T^2 + 2 I_3 P . P T,$$

so that

$$R T^2 - R T_3^2 = 2 (I P - I_3 P) P T$$
$$= 2 (I C - I_3 C_3) P T$$
$$= 2 (R E - R E_3) P T,$$

and the area T T_1 T_2 T_3 is thus P.T times the reading W W_1 of the wheel on the graduated bar.

As before, any complicated area can be dissected into analogous elementary contours $\tau\,\tau_1\,\tau_2\,\tau_3$, in Fig. 9, and now the reading of the wheel on describing the contour is the same as that obtained in going round the elementary contours in succession, so that the planimeter registers the area.

For other explanations of the theory, depending on an analysis of the elementary movement due to a small stop along the contour, the reader may consult Henrici's "Report on Planimeters" to the British Association, 1894; and the Reports of Juries of the Great Exhibition, 1851. Professor Hele-Shaw has also given a very complete historical account of the subject in a paper in the Proceedings of the Institution of Civil Engineers, April, 1885. An elegant demonstration, due to Mr. Macfarlane Gray, will be found in Carr's "Synopsis of Pure Mathematics;" also in Maxwell's "Collected Works," vol. i., page 230.

If the pivot P is clamped in the position in which the graduated bar C D points towards the fixed point R, then T can describe a circle round R without any movement of the wheel W along the bar C D; this circle is called the zero-circle, and in those cases where the area to be measured is so large that the instrument cannot cover it without placing the fixed point R inside the contour, the reading of the roller records the area of the contour less the area of this zero-circle, which area must therefore be added to the reading to obtain the true area.

The price of the instrument is 15 dols., or about £3. It is procurable from James L. Robertson and Sons, 204, Fulton-street, New York City; also through Elliott Brothers, of St. Martin's-lane, W.C.

HARBOURS AND WATERWAYS.

Harbour and dock bills.—The number of Bills of which notice has been given for the coming session, relating to piers, docks, rivers, and canals is fourteen, which is about the average of the last ten years. None of the Bills relate to works of first-class importance. The development of inland navigation, of which so much was heard a few years ago, does not make much progress, if the number of Bills brought before Parliament is any indication of progress. Only one canal Bill was introduced last year, and the principal feature in that was abandoned during its progress through Committee. This year only two Bills relating to canals have been brought forward, and one of these is for the abandonment of a navigation.

The greatest amount of progress in dock and harbour work, as shown by the notices given, is on the Mersey. The Mersey Docks and Harbour Board have given notice of their intention to apply for powers to enclose Tranmere Bay by means of a river wall about one mile in length, and to construct a dock or basin within the enclosure. The idea of converting Tranmere Pool into a dock is not a new one, as some time ago the Dock Board acquired sufficient land in the locality for the purpose. The construction of this river wall may give rise to some questions as to its effect on the channels on the Birkenhead side of the river, as the wall will probably lead to some disturbance of the tidal flow, whether advantageous to the general *régime* of the river or not, being a matter on which, no doubt, opinions will considerably differ.

The London and North-Western Railway Company, the owners of Garston Dock, proposes to construct an additional dock, partly on land belonging to the company, and partly on the foreshore of the estuary. The Manchester Ship Canal Company has given notice of its intention to apply for power to purchase the racecourse, which adjoins the canal and has an area of about ninety-nine acres, for the purpose of providing further dock and wharf accommodation and railway sidings. It is proposed to construct a new dock near the Mode Wheel Lock, with railway connections therewith; and also to obtain parliamentary sanction for the sale of the Duke's Dock at Liverpool to the Mersey Dock Board. It is anticipated that the sale of the Duke's Dock will provide the money for the purchase of the racecourse. With regard to the acquisition of this property, a rather singular dispute has arisen between the canal company and the Trafford Park Estate Company. Under an agreement made in 1893 the canal company was to have the option of purchasing the racecourse, if ever the ground should cease to be used as a racecourse. The racecourse company, having acquired another site as a racing ground, has now sold the present racecourse to the Trafford Park Estate Company, of whom Mr. Marshall Stevens, the former manager of the canal company, is secretary, in violation, as the canal company contend, of the agreement which had been entered into, and after it was known that the company intended to apply to Parliament for leave to extend its docks in this direction.

Another scheme affecting the canal, for which parliamentary sanction is to be asked, is that for acquiring the ferry rights and obligations for crossing the Mersey and the canal between Widnes and Runcorn, and for constructing a transporter bridge worked by electricity.

The scheme for constructing a sea wall in front of Seaforth and Waterloo on the Mersey, for which it was intended to apply for parliamentary powers in the coming session, has fallen through, the voting of the ratepayers, under the Borough Funds Act, showing an adverse majority. The proposal to protect the front of these places, in which there is a large residential population, has been agitated for several years. The Waterloo Local Board first brought forward a scheme which was to cost from £16,000 to £20,000. The one which has now been defeated was promoted by the District Council for a wall 2800 yards long, and enclosing about 58 yards in width of the beach, and an area of 33 acres, the estimated cost, as officially put forward, being £66,000, but which it was anticipated would be increased to £100,000 by the purchase of land required and other matters. As the resident population is only 23,000, it is hardly to be wondered at that the ratepayers should object to such an expensive luxury.

The Clyde Trustees are going to Parliament in the coming session to try and obtain powers to construct the dock at Shieldhall, which was rejected by the Committee last year, when leave was obtained for the one at Clydebank, and for the dock promoted by the Renfrew Corporation. The proposed dock is to be 20 acres in extent, which is smaller than that of last year, and by the present scheme the Renfrew-road is to be diverted, and the plans have otherwise been modified to meet the objections raised last year.

Notwithstanding the failure of the syndicate which proposed to purchase the Maryport Dock in Committee last session, notice has been given of a Bill for the incorporation of a company to obtain possession of the harbour and docks, and to build a new dock, and to deepen and widen the entrance channel. Power is also to be asked for to enable the London and North-Western Railway and the Maryport and Carlisle Railway companies to subscribe towards the capital. The collieries and ironworks in West Cumberland owe their existence to the facilities afforded by the Maryport and Workington Docks, and there is considerable rivalry between the two ports. As soon as the Maryport Bill was thrown out last year, the Workington authorities at once set to work to attempt to revive the negotiations for the purchase of the docks from the Earl of Lonsdale, which, after being brought to an apparently successful issue, suddenly collapsed, and Parliament will be asked to sanction any arrangement come to, and for power for the Workington Corporation to enlarge and improve the existing docks.

The Yarmouth Port and Haven Commissioners are seeking powers to consolidate and amend the various Acts relating to the Trust, to impose new tolls, to borrow money; to erect new stores, quays, and wharves; to obtain fresh power as to the removal of wrecks; to transfer the Haven Bridge to the Corporation; and to make bye-laws for the regulation of the traffic in the Haven and in the rivers Bure and Waveney, and for the regulation of pleasure boats.

The Scarborough Corporation have given notice of a Bill dealing with the new sea wall and the approach thereto, and for altering the constitution of the Harbour Commissioners, and to enable them to borrow further money for improvements.

The Bill which is being promoted by the London and India Dock companies, for parliamentary sanction to an amalgamation of the two undertakings, and for power to impose a toll on barges, has already been dealt with in a previous number.

The Dundee Harbour Trust have determined to seek powers to increase their borrowing powers to the extent of £100,000, for the purpose of erecting additional coal hoists, the formation of a fish dock and quays, and other purposes.

The Shoreham Harbour Trustees have given notice of their intention of applying for powers to extend the western pier of the harbour to a distance of 80 yards below low water, and the eastern pier for a distance seaward of 123 yards; also for the construction of a wet dock of 13 acres, with a lock 50ft. wide, having 20ft. of water on the sill at high water neap tides.

The Ilfracombe Harbour Authority make application for a Provisional Order for power to construct a new pier or jetty, extending 250 yards from the seaward end of the existing landing berth, and to erect a lighthouse near the extreme northern end of Beacon Point.

Notice has been given by the Trustees of the Market Weighton Drainage and Navigation of their intention to apply to Parliament for leave to close their navigation, and for obtaining further powers as to the drainage of lands by the canal; power is also to be asked to transfer the maintenance of the bridges which carry highways over the canal to the highway authorities. The original Act for this navigation was obtained in 1772, the main purpose of the promoters being the drainage of Walling Fen, the navigation being a subsidiary matter. The canal is nine miles in length, and extends from Market Weighton to the Humber. In 1855 the subscribers transferred their interest in the navigation to the North-Eastern Railway Company. Ten or twelve years ago the receipts began to decline, owing, as is said in the neighbourhood, to the neglect of the railway company in maintaining the canal in a navigable condition. While the closing of the navigation would be of advantage to the landowners, as the canal could then be turned into a warping drain, and a great deal of poor land improved, it would be disastrous to the brick trade which is now carried on at Wallingford and Newport. The Bill is threatened on this ground with opposition from the traders, who will probably be supported by the Aire and Calder Navigation Company, who intimated at a conference that was held in the summer that they would strongly oppose any attempt to close the navigation.

King's Lynn.—Considerable complaints having for some time past been made as to the difficulty of getting up to the quays in the river Ouse, the Conservancy Board, on the recommendation of their engineer, Mr. Silcock, have decided to have the mud on the foreshore in front of the quays removed, so as to allow of vessels drawing 15ft. to be berthed near enough to the quay to discharge by means of a 40ft. gantry. For the removal of this mud an Eroder dredger is to be used, similar to the one that has been successfully in use for removing shoals in the channel and maintaining the berths at the quays at Boston for some years. By aid of this machine the cost of removing the mud will be very small.

London Docks.—The London and India Dock Company, in order to meet the requirements due to the continued increase in the size of steamers, have decided to lengthen and deepen the entrance to the South-West India Dock. The present entrance is 300ft. long, 55ft. wide, and 27ft. deep in the centre, but as the invert is curved, the available depth for large vessels with broad beams is only 23ft. 6in. The entrance is to be lengthened to 480ft., and deepened to 29ft., which will give access to eleven deep-water berths. During the alterations vessels will enter and depart by the Blackwall entrance of the West India Dock.

Plymouth.—Considerable improvements have recently been made in the navigable facilities of Sutton Harbour. On the eastern side a new quay 500ft. long has been constructed, making, with the existing quay, a total length of 900ft. This quay is in connection with the Great Western Railway, and it is hoped that the South-Western will also obtain running powers on to it. A five-ton movable hydraulic crane will be available for any part of the quay. On the north-east quay two large sheds are being constructed. The harbour has been dredged and deepened, so as to give 22ft. at the quays at high water spring tides and 7ft. at low water.

Antwerp.—The Belgian Government and the municipality of Antwerp have decided to proceed with the construction of two new docks, which will increase the area of the port 25 per cent. The great works of improvement which have been carried out, or are now in progress, at this port, have led to a large development of trade, and made Antwerp one of the first ports of the Continent; but the facilities for the berthing, loading, and discharging of vessels provided at Rotterdam have drawn a great deal of trade away which otherwise would have gone to Antwerp, and hence the necessity of further progressive works.

THE MINES AND MINERALS OF VICTORIA.

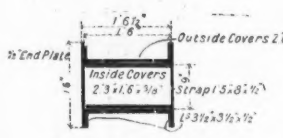
A SPECIAL edition of the *Australian Mining Standard* has been sent to us. The whole volume is devoted entirely to the description of the mines and minerals of the Colony of Victoria, and extremely interesting it is. From the date of its first discovery to the present time, some 400 million pounds worth of gold have been discovered in Australia. Of this total, 250 millions have been found in Victoria, which is therefore the largest producer of the seven Colonies. Originally the gold lay practically on the surface, and there was no difficulty in obtaining it. Now, however, in the majority of cases, the metal has to be sought by mining, sometimes at very considerable depths. For instance, the shafts at Bendigo are no less than 3500ft. deep.

Methods are very different now from what they were fifty years ago. Then gold digging was to a large extent mere surfacing and pure speculation. Now it is a great scientifically-directed and well-organised industrial enterprise. The output now-a-days is barely a third of what it was in the "fifties," this being accounted for by the increased difficulty in mining; but during the last eight years the amount obtained has been steadily on the increase, and last year it was 837,258 oz. In the earlier days gold was obtained with the primitive appliance of windlass, tub, cradle, and tin dish, and the wonderful returns from the shallow alluvial leads precluded all idea of recourse to more systematic and patiently laborious methods. Claims were worked till the miners became dissatisfied with the yield from the wash, or till some richer attraction drew them away in another direction. Even in districts which gave phenomenal returns for the labour expended upon them, the claims were abandoned as soon as the water was reached. At length, however, when the surface gold, or that near the surface, had been all gathered up, the more systematic prosecution of the mining industry became imperative, and latterly the working of deep leads and quartz lodes has become the mainstay of the mining industry. In the "fifties" and "sixties," claims yielding 2 oz. to the ton were abandoned as unprofitable. In the "eighties" and "nineties," stone yielding but 4 dwt. was raised from a depth of 3000ft. at Bendigo, and crushed at a profit. It has been proved that gold-bearing stone dives down, at all events, to a depth of 3500ft. The Government are using every endeavour to encourage mining in all districts, and are spending large sums of money annually in exploration, boring operations, &c. In this way the trend of the deep leads is being mapped out. This is leading to the re-opening of mines previously imagined to be worked out. The various recovery processes, too, are proving that discarded waste heaps can be made to be highly remunerative.

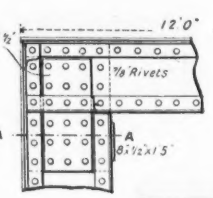
Victoria has proved to be so rich in gold that little attention has been paid to other mineral deposits. These are, however, many and varied, both as regards those ranging under the metallic and non-metallic heads. Silver has been found in many places. Galena in rich deposits is being worked at Mount Deddick, in the Gippsland district. Quicksilver is being obtained near Jamieson. Copper is found in many places—at St. Arnaud, Bethanga, on the Thompson River, and in Gippsland, where native copper is found associated with other ores of copper in the form of carbonates and pyrites. It also occurs in small quantities at Steiglitz, Castlemaine, Bendigo, and other places. Tin occurs in numerous places in the district of Beechworth, in the beds of tributaries of the Yarra, Thompson, and Latrobe; also at Taradale, Franklin—Gippsland—and Strathbogie. Antimony, in the form of sulphuret and oxide, is found at Heathcote, Whroo, Anderson's Creek, Ringwood, Merton, near Mansfield, and Nunawading, near Melbourne. Zinc has been found at Daylesford, also in Gippsland; lead at Talbot, Avoca, and Gippsland; cobalt at Yea; bismuth at Omeo and Tarrangower; manganese at Pleasant Creek, Daylesford, and Gippsland. Kaolin has been discovered at Bulla Bulla, near Melbourne, and at Beechworth; bitumen, near Portland; iron is found at Lal Lal; gypsum at Kerang and Bridgewater. Marble quarries have been opened between Toongabbie and Walhalla. Molybdenite—sulphite of molybdenum—has been obtained at Bulgoback (Gippsland). Near Stockyard Creek, osmiridium has been collected in small quantities. It appears also that Victoria is by no means destitute of gem stones. Diamonds and sapphires have been found in the north-eastern parts of the Colony, at or near Eldorado, the Woolshed, and Pilot Creek, in the neighbourhood of Beechworth. Turquoise has also been discovered in the Beechworth district. It is found in dark grey-slate, most likely of Silurian age. The belt is 23 yards wide, and is bounded by beds of sandstone. The turquoise occurs in short, irregular tortuous veins, crossing the slate at all angles, and being a ¼in. to ½in. in thickness in exceptional instances. At the surface, and for a few inches below, the turquoise is bleached and of a greenish hue, but at a depth of 2ft. to 3ft. it is of a lovely pale-blue colour, which shows as distinctly by artificial as by daylight. The most valuable mineral, however, after gold, is coal, the value of which in 1898 was £699,825, having grown in ten years to this figure from £24,864 in 1888. The value of the tin mined in 1898 was £691,987, this being only a comparatively small increase on the figures for 1888, which was £669,071.

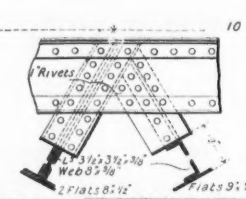
The whole mining industry appears to be carried on in the most scientific manner. Details of nearly every mine are given, and in many instances the details are supplemented by photographs. Evidences are everywhere visible of a wonderful activity. Substantial buildings and high brick shafts are now-a-days the usual adornments of a shaft head,

HUNSLET RAILWAY—BRIDGE OVER THE MIDLAND RAILWAY—DETAILS



Section of End Plate at A A.





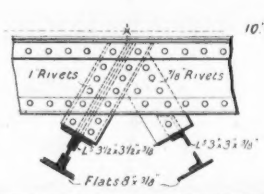
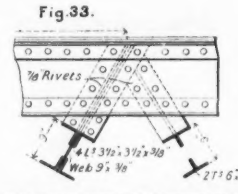
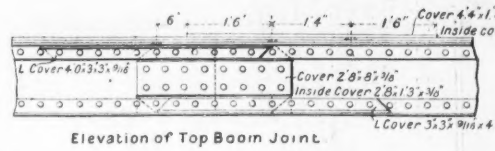


Fig.33.




6"
1'6"
1'4"
1'6"
Cover 4'4" x 1'6" x 9/16
Inside cover 4'4" x 9 ⅝ x ⅜
L Cover 4 0 x 3 x 3 x 9/16
Cover 2'8" x 8 ⅝ x ⅜
Inside Cover 2'8" x 1'3" x ⅜
L Cover 3 x 3 x 9/16 x 4'0"
Elevation of Top Boom Joint.

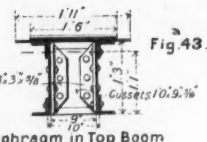
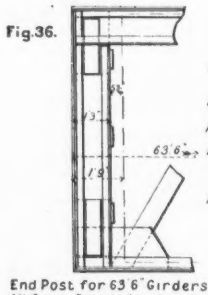


Fig.43.
Diaphragm in Top Boom at Centre of Each Bay.



End Post for 63'6" Girders
All Other Details Same as for 64'0" Girders

Note
All Rivets except where otherwise specified, to be ⅞ Diam and 4" Pitch
All Rivets thro Buckled plates to be ⅞ Diam & 8" Pitch
All Ends & Edges of Plates & Ends of Bars to be Planed
All Portions of Steelwork inaccessible for Painting to be served with 2 Coats of Tar & a layer of Felt between
All Rivets on Bearings to be Countersunk

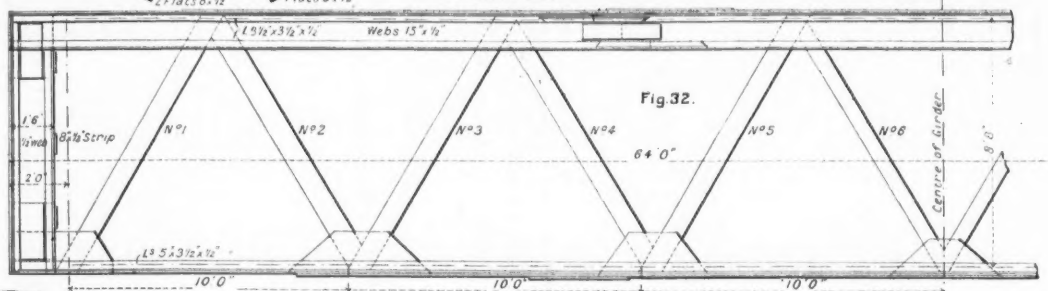


Fig.32.

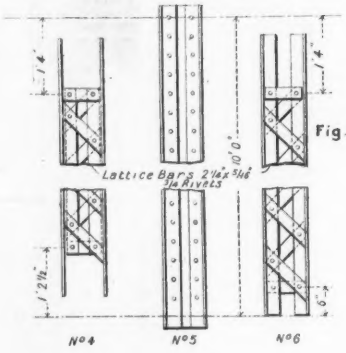


Fig.44.

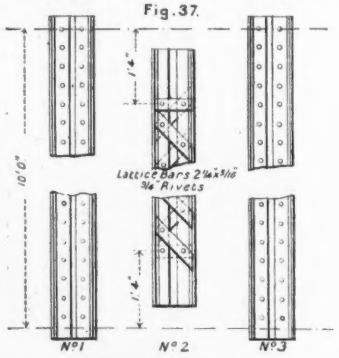
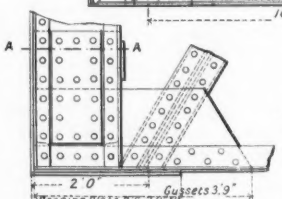


Fig.37.
Elevation of Diagonals



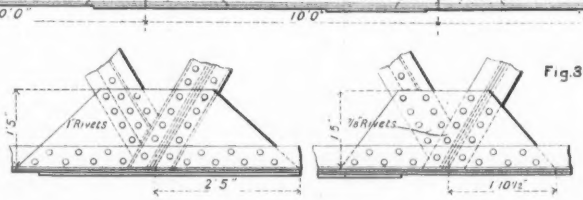
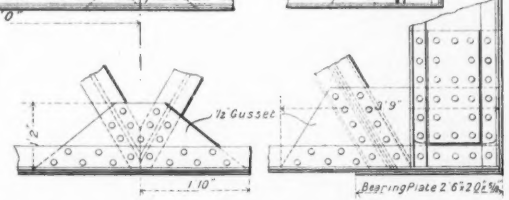


Fig.34.



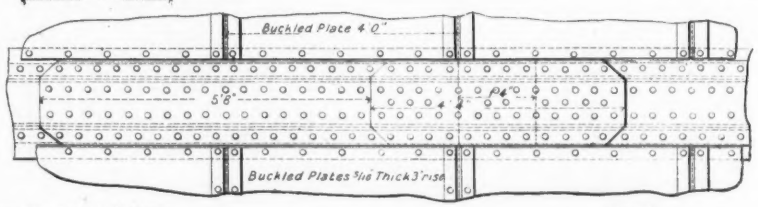
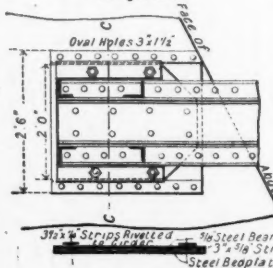


Fig.39

No 4 Girders Required 64'0" Long
No 3. " " 63'0" "


Face of Girder
Oval Holes 3" x 1 ½
2'6"
2'0"
Abutment
3½ x ⅝ Strips Riveted to Girder
⅝ Steel Bearing Pl
3" x ⅝ Strip
Steel Beadplate 2'8" x 2 6 x ¾
1¼ Lewis Bolts Run With Lead
Section on C.C.

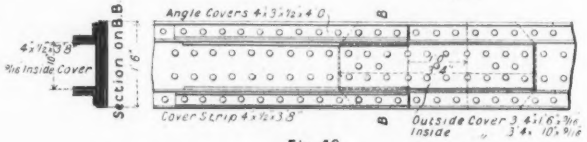


Fig.40.

Sliding Surfaces to be Planed & Lubricated

Fig.41.

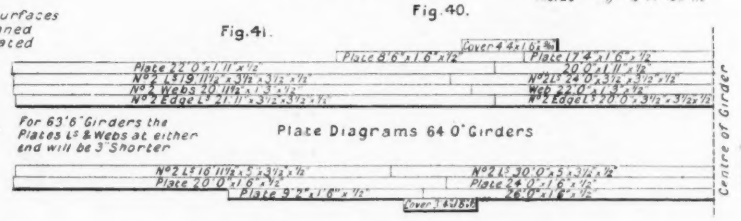


Plate 8'6" x 1'6" x ½
Cover 4'4" x 1'6" x ⅝
Plate 17'4" x 1'6" x ½
Plate 22'0" x 1'11" x ½
20'0" x 1'11" x ½
No 2 L 3 9 11½ x 3½ x ½
No 1 Webs 20 11½ x ½
No 1 Edge L 3 x 1 1 x 3½ x ½
No 2 L 3 24'0" x 3½ x ½
Web 24'0" x 1'4" x ⅜
No 2 Edge L 3 20'0" x 3½ x ½
For 63'6" Girders the Plates L s & Webs at either end will be 3" Shorter
Plate Diagrams 64'0" Girders
No 2 L 3 10 11½ x 3½ x ½
Plate 20'0" x 1'6" x ½
Plate 9'2" x 1'6" x ½
No 2 L 3 30'0" x 3½ x ½
Plate 24'0" x 1'6" x ½
26'0" x 1'6" x ½
Cover 1'6" x 8"
Centre of Girder

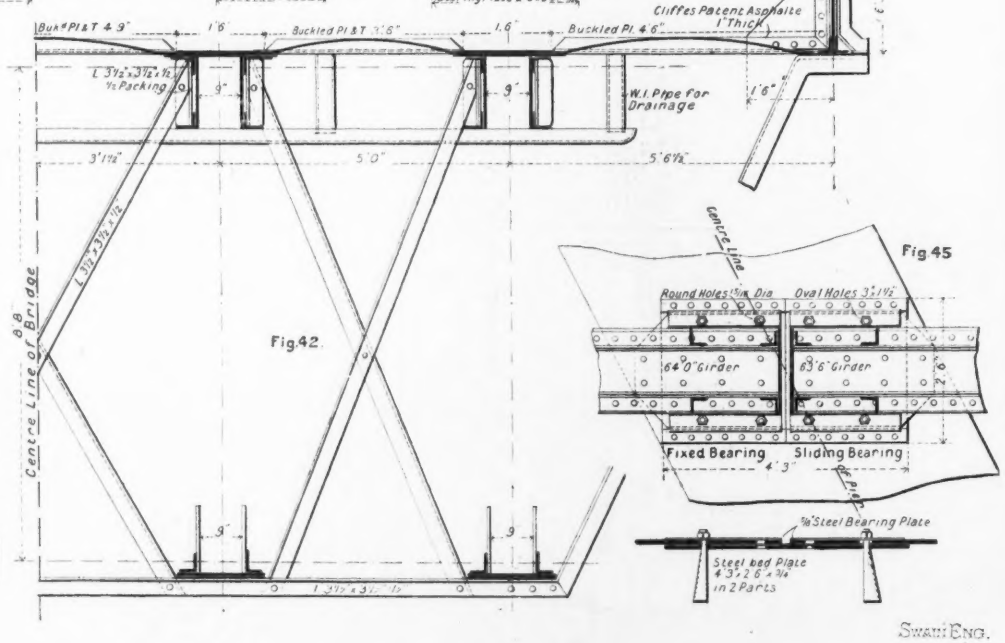
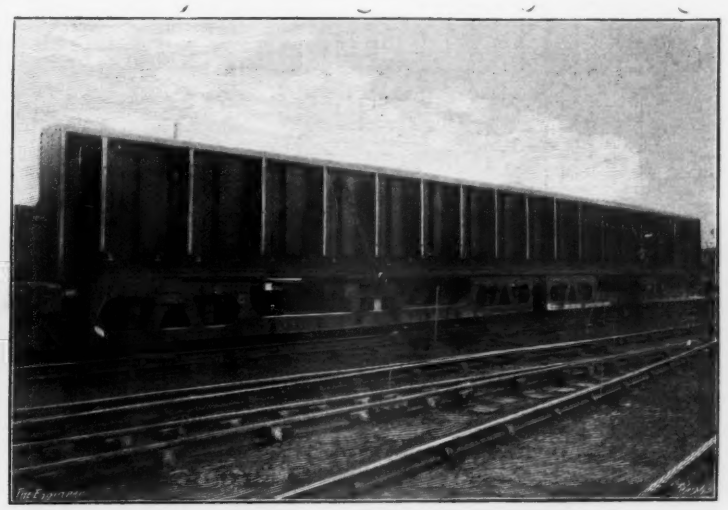


Fig.42.

Fig.45

SWAIN ENG.

HUNSLET RAILWAY—WAKEFIELD ROAD BRIDGE AND GIRDER



and the hand windlass has been long since ousted by the power-driven derrick. Engineering skill has been largely taxed, and the results reflect credit on those who have been reponsible for them, and on the Government, who have fostered and assisted the search after gold.

We have before us the monthly return for August, 1899, made by the Government. It deals with over 400 gold mines, giving statistics for each, such as the yield of gold for the months, the quantity treated to date and during the month, the extent of the property, the number of stamps, &c., which are most interesting reading. The actual gold production of the whole number for the month of August was 81,875 oz. This year, to that date, the production was something over 18,000 oz. in excess of the output in 1898 to the same date. This return also sets out the records of the various boreholes which the Government have caused to be sunk with a view to tracing out the directions taken by gold-bearing reefs.

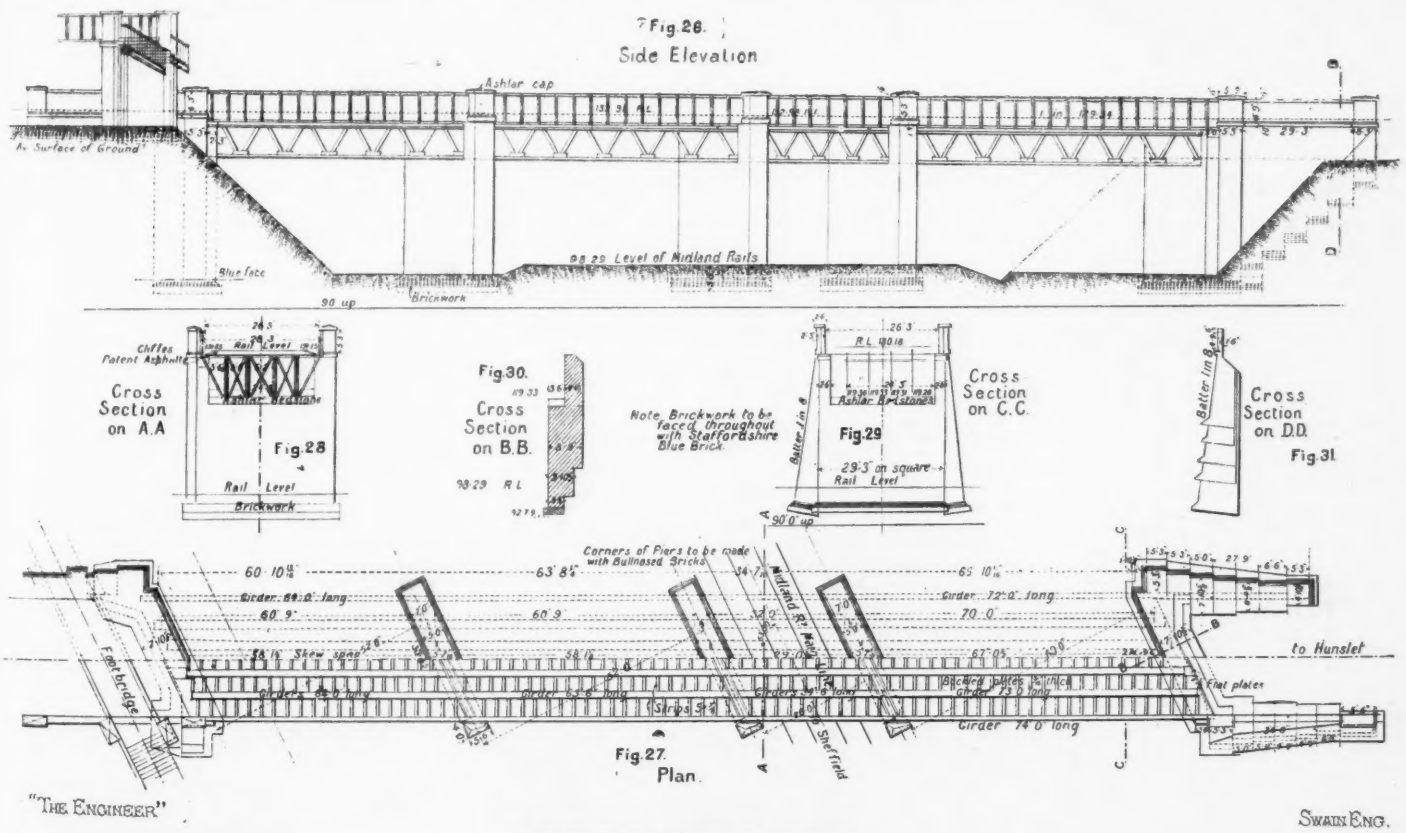
THE GREAT NORTHERN RAILWAY.

No. II.

NEW BRANCH LINE AND STATION AT LEEDS.

WE resume our description of the principal important engineering works of construction upon this line, at the point where it crosses the route of the Midland Railway to the one bridge throws to the right and the other to the left, as in the plan in Fig. 27. The wing-walls are of the straight-back pattern, stepped up with the slope of the ground, as can be seen from the plan, the elevation, and the cross section in Fig. 31, taken along the line D D in Fig. 26. The spans, both on the square and the skew together, with the total lengths of the main girders, the foot-bridge, and other dimensions, are all so marked on the plan as to render any further description of it unnecessary. Two complete transverse sections are given in Figs. 28 and 29, the former of which is made through the small intermediate span of 32ft, and the latter in front of the right-hand abutment, both on a line perpendicular to the longitudinal axis of the bridge. In all the deck bridges on this branch railway, in which the piers form angles more or less acute with the direction of the tracks, it becomes necessary to retain the ballast in position, and, in addition, to provide for the contraction and expansion of the metallic parts of the structure. A cross section on a small scale of the expansion joint, expressly designed to meet these requirements, was published in our first article, and in our next we shall give further particulars and drawings, descriptive and illustrative of the ingenious arrangement adopted.

The next illustration, Fig. 32, represents an elevation, in outline, of the half of one of the girders, having a total length of 64ft., and presumably an effective depth of 8ft. 8in. measured between the dotted lines shown in Figs. 32 and 42. The details of the half elevation are shown in Figs. 33 and 34. In the former, the varying sectional areas of the alternate ties and struts, increasing from the centre towards the abutment, in obedience to the law governing the stresses upon all the vertical and inclined members of any open web girder or truss with parallel horizontal booms, are fully figured, so that they can be readily estimated, more so than in the case of the bowstring and the fish-bellied trusses, in which one or other of the booms is curvilinear in shape. It should be noticed, in comparing Figs. 33 and 34, that in the elevation of parts of the upper boom, as also apparent in Fig. 32, there are not any gusset pieces, whereas, in Fig. 34, the lower apices formed by the intersection of the diagonal ties and struts of the web with the lower boom are united to it by the aid of gusset pieces. These are, except at the central bay, where the depth is reduced to 12in., 1ft. 3in. in depth by half an inch in thickness, or exactly the same scantlings allotted to the vertical side plates in the upper boom. The function of both is the same, namely, to afford sufficient rivet area for the attachment of the diagonal bars of the web to the booms. A main reason for the continuous beam section in the upper boom is the provision of the strength required to carry the concentrated wheel-load on on each bay. A reference to Figs. 33, 37, and 44, will show the manner in which the compressive and tensile members of the web—Nos. 1 to 6—are built up. The struts are simply small plate girders, composed of the usual upper and lower horizontal flange plates, angle struts, and solid webs, while in the ties the flanges are connected by lattice bars 2½in. by $\frac{5}{16}$in., and rivets ⅞in. in diameter. All the web members are braced to enable them to sustain the amount of compressive strain produced in them by the rolling load. It will be seen that in the elevation of the top boom joint the rivets in the same vertical planes break joint, so that the difference that always exists between the gross and net sectional areas of the perforated plates is reduced to a minimum. Each panel is 10ft. in length, and at the centre of those in the upper boom a solid plate diaphragm—Fig. 43—is inserted



BRIDGE OVER THE MIDLAND RAILWAY

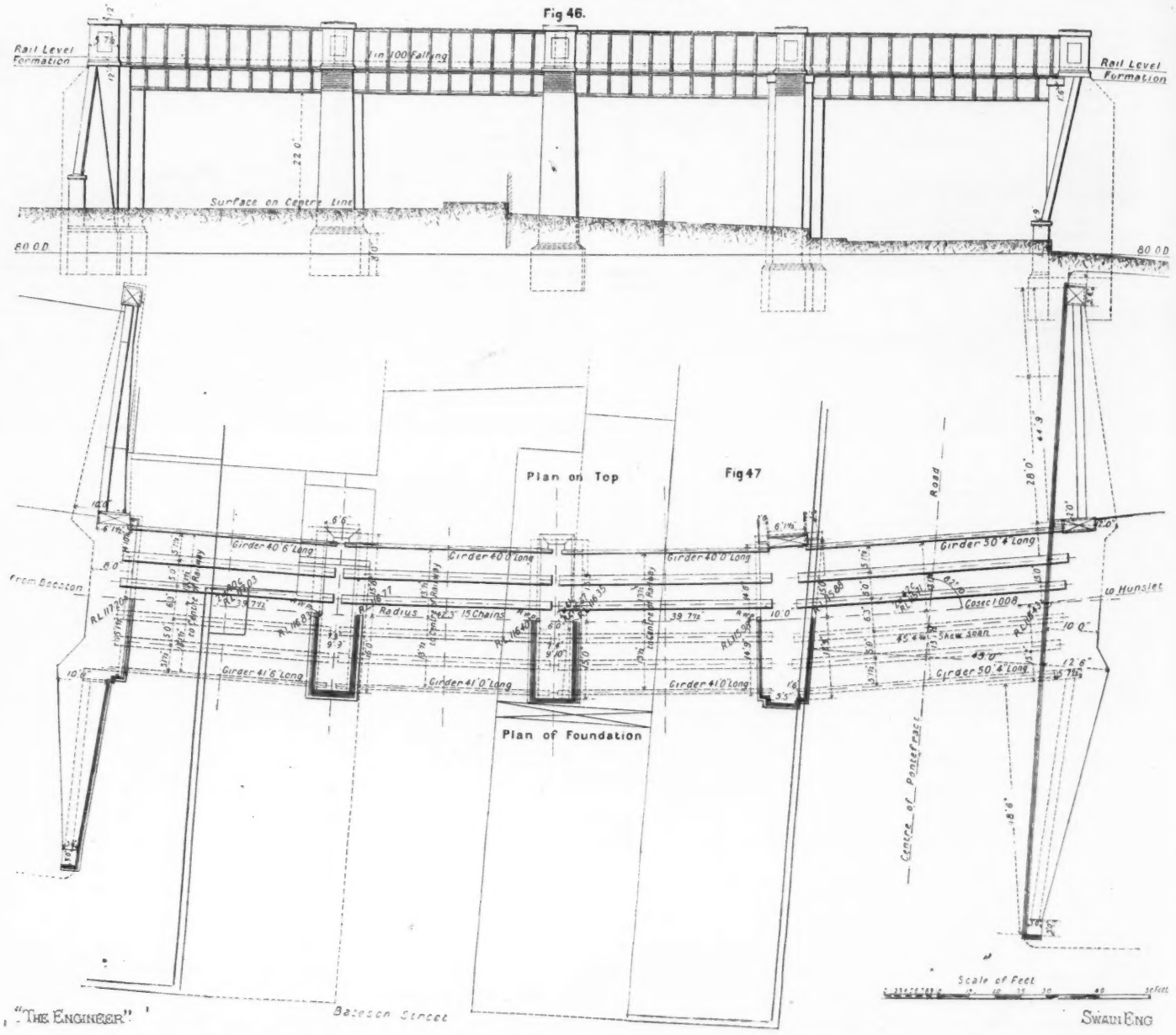
Sheffield, by a very good-looking bridge of four spans, of which an excellent photograph was published in our first article. All the spans are upon an angle of skew of 63° 30′, but vary considerably in their respective dimensions. Two of them measure 60ft. 9in., a third 70ft., and the fourth 32ft. This structure, which is shown in elevation in Fig. 26, is of the same type as the viaduct at Middleton Colliery, previously described and illustrated, and with the exception of some differences with respect to length of spans, angle of skew, and a few other minor points, very much resembles it, in both general features and in details. While the angles of skew differ by just five degrees, that of the viaduct being the flatter, their directions are not the same; in other words, to stiffen the boom, which undergoes a stress of compression, a precaution which is unnecessary in the lower boom subjected to a tensile stress. On referring to Fig. 39 it will be observed that a similar arrangement for the joints and wrappers, or cover plates, for the horizontal flange plates is adopted as for the vertical plates of the upper boom previously mentioned. A transverse section at the centre of the bridge is given in Fig. 42, and both the fixed and sliding bearings, steel bed-plates, and holding-down bolts are given in Fig. 45, which completes the description of the entire structure.

Following the line for a short distance further in the direction of Hunslet, we cross the Leeds and Pontefract road by a

HUNSLET RAILWAY—BRIDGE OVER PONTEFRACT ROAD

(For description see page 617)

Fig 46.



viaduct of four spans of the following respective lengths,—for two spans of 39ft. 7½in., one of 42ft. 3in., and a fourth of 45ft. 4½in. An elevation and plan are given of this viaduct in Figs. 46 and 47. It is situated in an embankment nearly 30ft. in height, which accounts for the great length of its wing-walls, and upon a curve with a radius of fifteen chains. The superstructure consists of steel plate girders 4ft. 6in. in depth, with outside parapet girders, and is designed on the deck principle. The total absence of any splay to the wing-walls of the abutment on the right-hand end of the bridge is a noteworthy feature, as it is of somewhat rare occurrence.

LIVERPOOL SELF-PROPELLED TRAFFIC ASSOCIATION.

The first meeting of the session of the above Association was held at the Royal Institution, Liverpool, on Tuesday last, the Earl of Derby, K.G., G.C.B., president, being in the chair. At the meeting the report on the trials held in the summer with heavy vehicles was presented, which two of the judges, Mr. Everard R. Calthrop and Professor H. S. Hele-Shaw, LL D, F.R S, supplemented with remarks.

Mr. Calthrop dealt more particularly with the question of the present tare limit, and said that the trials showed the great difficulties in making a vehicle which should carry at least four tons and yet comply with the legal limit, in spite of the improvements shown and the great ingenuity displayed with the vehicles entered for the late trials. It was essential that loads of six, eight, and ten tons should be carried as with horse lurries, and the three-ton tare limit could not be defended. The legal speed limit of five miles an hour was quite fast enough at present, until the horses, &c., were educated to the appearance and behaviour of the vehicles. The tare difficulty should be got over by allowing as large a load per axle as with horse-drawn lurries, although it might be advisable to broaden the tires. The judges were satisfied that were it not for the tare limit vehicles could be made to carry anything anywhere.

Professor Hele-Shaw dealt with the nature and construction of the vehicles, and pointed out that all the competing cars were rear drivers, and used Ackermann's system of steering, which latter was not only the most convenient, but also the safest method. All the vehicles which competed were steam-driven and had the boiler in front. Steam had a great advantage over every other system owing to its flexibility; the differences between the cars were in the position of the engine, in the use or omission of a cab—and there seemed to be a question as to whether a cab was advantageous—in the boiler, which was either fire-tube or water-tube, and in the class of fuel used, as vehicles ran using oil, coke, and coal. Differences also occurred in the form and make of wheels, in the method of transmission, and in the use of a condenser. Comparisons were sometimes made between a locomotive and a motor vehicle, but it must not be forgotten that the former was not handicapped by weight, did not carry its load, and ran on specially-prepared roads, and was not like a motor vehicle, bound down to four points of support running on a varying gradient. In conclusion, he would point out that in some detail or the other each of the vehicles was excellent.

The Earl of Derby, in moving the adoption of the report and a vote of thanks to the judges, officials, and competitors, mentioned the special attention which the Liverpool Self-Propelled Traffic Association had paid to vehicles for heavy traffic. They were especially advantageous for comparatively short journeys, in that they did away with terminal charges. Undoubtedly the bad state of the roads affected the running, but they must be taken as found, or, rather, as the County Council left them. It was a matter of congratulation not only that the trials had been so successful, but that manufacturers were endeavouring to learn from these trials the defects existing in cars, and to remedy them. It was therefore worth while going on with them, and he trusted that a third series might be held next year. It was doubtful if the Government would alter the existing Act so soon after having passed it, and even if an Amendment Bill were brought in it might cause trouble. He would do all in his power to assist in the alteration of the Act so as to allow of a greater tare limit, but would like to know first of all what support any move in the matter would be likely to receive. Much harm might be done by too precipitate action.

Mr. A. L. Jones, in seconding the motion, spoke of the way in which railways would benefit by the use of motor vehicles as feeders.

Mr. Dawson supported, and Mr. E. Shrapnell Smith, the honorary organising secretary, responded on behalf of the judges and officials; Mr. J. I. Thornycroft, F.R S., replying for the competitors. He spoke of the indebtedness of makers to the Liverpool Association in organising these trials, in which so much could be seen and learnt. With regard to the question of the effect on railways, he stated that one railway manager was using a motor lurry for delivery and collection of goods experimentally with a view to using motor vehicles for this work.

The two gold medals won by The Steam Carriage and Wagon Company, of Chiswick, were then presented to Mr. Thornycroft, whilst silver medals were given to the Lancashire Steam Motor Company, of Leyland, and to Bayley's, of Newington-causeway, London, and diplomas to Coulthards, of Preston, and the Clarkson and Capel Syndicate, of Deverell-street, London.

ALMANACS, DIARIES, &c.

We have received from Messrs. Neale and Wilkinson, of St. Mary Axe, London, a "tear-off" wall calendar for next year, on which is well depicted in colours a realistic view of Table Bay at sunrise, with the mail steamship Norman just taking her departure.

The Ocean Accident and Guarantee Corporation, Limited, have sent us a wall calendar of similar pattern, illustrated in colours by the lithographic process. The picture represents H.M.S. first-class battleship Ocean under way.

The Rugby Portland Cement Company has issued a large wall calendar of the monthly "tear-off" pattern, on which there are some remarkable illustrations representing the different geological periods. There is also a geological section across England from Holyhead to Dover.

The firm of J. T. Williams and Son, Bermondsey, have produced, in conjunction with a pocket calendar for the year 1900, a list of new and second-hand machinery for sale.

From Bamrose and Sons, Limited, we have received a set of twelve monthly pocket diaries of handy size.

The "Railway Diary and Officials' Directory for 1900," published by McCorquodale and Co., Limited, is, as usual, a highly comprehensive work in connection with the railway world. It includes a wall calendar.

E R and F. Turner, Limited, Ipswich, are responsible for a neat wall calendar of the daily "tear-off" pattern. There is a motto given with each slip, and some of these, to us, are amusing and quite original.

Merryweather and Sons, Limited, are issuing a wall calendar of the monthly "tear-off" pattern.

Institution of Civil Engineers: Glasgow Association of Students.—The second general meeting of the current session was held on the evening of the 4th inst., at the rooms of the Institution of Engineers and Shipbuilders, 207, Bath-street. Having met with an accident, Sir W. H. Preece, K.C.B., F.R.S., past-President of the Institution of Civil Engineers, was unable to deliver his promised address on "The Functions of the Engineer." The delivery of this has therefore been postponed till early in 1900. However, the President of the Association, Professor Archibald Barr, D.Sc., consented at very short notice to fill the vacancy thus regrettably formed, and gave a most interesting and complete description of the "Forth Bridge." Dr. Barr, by aid of many lantern slides, described the former schemes briefly, and followed in detail the construction of the now-existing structure. A very hearty vote of thanks to the lecturer terminated the proceedings.

OUR FIRE IN THE WAR.

THE serious loss of our field guns at Colenso has not unnaturally raised serious questionings in many minds. The accounts are at present very imperfect, but read as if our men were suffering from the artillery fire of the Boers from such a range that our guns had to advance so far to cope with them that they met with destruction from infantry fire. How comes it, it is asked, that our authorities cannot provide us with as good guns as the Boers manage to get? A letter from a naval officer says that our field material is wholly inferior to the guns landed by the Navy, and says that the reason is simply that the Navy have of late years acted for themselves instead of taking their guns from the War-office. All this suggests that our artillery authorities have indeed been asleep. It is no doubt sufficiently suggestive to prompt inquiry and examination into the matter. Those who undertake such inquiry will find the following to be the facts of the case.

The table herewith shows data concerning the chief continental Powers — Russia, Germany, France, and Austria. Dealing as we do with the newest guns, the data are very imperfect, but there is sufficient to show that our own field gun has the same muzzle energy as that of Germany. The German projectile, being 1 lb. heavier, would retain its velocity better, but not sufficiently to make much practical difference; indeed, our guns are sighted and have range tables up to 5300 yards, and the Germans apparently up to 5468 yards. It is clear, then, that, supposing the Boers to have employed the German service field guns, there was no reason for our guns to advance in the way they did. As to the Russian and Austrian guns, the former would be far worse than ourselves in the matter of trajectory. The latter is an experimental gun. It has apparently a very high velocity—a velocity which would give a flat trajectory and long range, but probably could not be fired fast because its recoil would be too violent. Range is not everything, nor is flat trajectory everything, seeing that in the opposite scale are speed of fire by controlled recoil and mobility, and searching behind cover. We think that probably most of our readers will agree with us in believing that Germany is, on the whole, the Power most likely to be right, and that our close agreement with Germany looks as if we were unlikely to be very wrong. The fact is that the reports of the battle are at present too vague to enable us to assert that we were "out-ranged" by the Boer guns, at the same time this is very possible, because they may have brought guns of position into action. The Boers had the advantage of occupying the ground deliberately before we came up; the regular purpose of guns of position is to defend ground thus prepared and entrenched, but we had to bring up our forces quickly, and with them came our field guns proper. We admit that this, while it vindicates the character of our field guns, as field guns, does not account for our having no guns of position following them. The naval guns were a sort of substitute for guns of position; that is to say, they were heavier pieces, weighing 12 cwt., as compared with 7 cwt. for our field battery, and 6 cwt. for our horse artillery. Their velocity and energy are much higher, but we do not yet know what they effected. We have before discussed the question of their mobility. On the whole, we think there is no ground furnished for objecting to the design of the field gun, as we have before said, fitted with the Clarke brake; we believe that it would hold its own against any field gun extant or likely at present to come in. The selection and supply of guns and ammunition is another matter. We are certainly inclined to believe that howitzers and guns of position ought to have gone out to the war sooner. The 5in. howitzer shown in the table is a valuable piece, and those with Lord Methuen have proved themselves such, being the pieces that discharged shells filled with lyddite, two of which were reported to have struck between 50 and 70 men each. It will be seen in the table that foreign guns have common shells containing high explosives as well as shrapnel in their equipment, and we think that we ought to have had the same, though it should be understood that the comparatively high velocity and consequent flat trajectory of the field gun proper would prevent the common shell from searching behind corners and striking men in the way the crossed fire of the howitzer enables it to do.

Elements of Power in English and Foreign New Type Field Guns.

Nation.	Calibre of bore in inches	Weight of projectile, lb.	Muzzle velocity, ft.-sec.	Muzzle energy, ft.-tons.	Weight of Load behind team, cwt.	Range sighted up to, in yards.
Germany ...	3·03	15	1525	211·8	33	5468
France ..	2·95		at pres	nt k-p	secret	
Russia ...	3·42	15·2	1355	193·5	—	—
Austria ...	3·07	13·2	1800	ex	perimen	tal
England	3·00	14·06	1574	241·4	32¾	5500
			Hor	se Artill	ery.	
England ...	3·00	12·5	1553	—	31	5200
			Fiel	d Howitz	er.	
England	5·00	50	782	—	—	4900*

* (at 42 deg. 24 min. elevation.)

Lastly, one word again as to lyddite. We have before said that it is practically identical with melinite, both consisting of picric acid run in with a little other matter, which is itself nearly the same in the two explosives. The Boers are reported to have used melinite about Ladysmith. They were not successful at first in bursting it. Our arrangements for that purpose are very effective, but are confidential. Doubtless the Boers will before long succeed in bursting their shells also, but in the meantime we hardly suppose that even the advocates of the Boer will contend that, having charged his shells with melinite, his humanity caused him to employ inefficient means of ignition.

The despatch of 5in. guns shows the appreciation by our authorities of the need of guns of position. We hope that data may be obtainable of this piece and its carriage. The gun itself must be the 5in. gun of 38 to 40 cwt., discharging a 50 lb. projectile with a muzzle velocity of 1750 foot seconds, being, of course, a piece totally different in power from the 5in. howitzer.

THE FRENCH WINTER TRAIN SERVICES.

By CHARLES ROUS-MARTEN.

IN each of the past few years the train services of France have shown marked progress with respect to speed. These various stages of advance have been duly recorded by me in the columns of THE ENGINEER. But the present winter has wholly transcended all its predecessors, and also even last summer, in the brilliance of the express work that it has provided. I give a list of the chief expresses in France, as set forth in the official time-tables. It will be noticed that that enterprising cross-country line, the Midi, completely distances anything ever yet seen in Great Britain in the way of booked speed. both as to the journey rate, inclusive of stoppages, and in the best start-to-stop run. Further, the "*train facultatif*" of last summer, on the Nord line, has now become the Calais-Mediterranean express, running regularly four times a week. Also the so-called "Nord" express, which used to run only twice weekly, and then as a strictly limited "*train de luxe*," now runs daily without any such limitation. From personal experience, I am able to state that time is not only kept, but gained, even with considerable and sometimes heavy loads.

No train which is booked at a lower speed than fifty miles an hour from start to stop is recognised in my list as "express." This unfortunately shuts out the Etat which at present does not possess any train booked at fifty miles an hour from start to stop. All distances are given in English miles, and to the nearest quarter-mile; all speeds in English miles per hour; all times to the nearest quarter-minute; and all loads in English tons, exclusive of the weights of engine and tender.

French Expresses.—Complete Journeys, including Stoppages.

Rly.	Station.	Distance, English miles.	Booked time. h m.	No. of stops.	Total stoppages. min.	Journey rate, including stops. m h.
Midi ...	Bayonne—Bordeaux (Controle)	123	... 2 8	... 2	... 2	... 57·7
Nord...	Paris—Calais Pier	185½	... 3 5	... 1	... 5	... 57·1
Midi ...	Bordeaux—Bayonne	123	... 2 12	... 2	... 2	... 55·8
Midi ...	Bayonne—Bordeaux	123	... 2 15	... 2	... 2	... 54·7
Orleans	Paris—Bordeaux	363¼	... 6 42	... 4	... 17	... 54·2
Nord...	Paris—Jeumont (Frontier)	148	... 2 45	... 1	... 5	... 53·8
Orleans	Bordeaux—Paris	363¼	... 6 52	... 4	... 17	... 53·0
Orleans	Paris—Bordeaux (St. Jean)	363¼	... 7 5	... 4	... 17	... 52·4
Nord...	Paris—Feignies (Frontier)	143½	... 2 46	... 1	... 4	... 51·9
Nord ..	Lille-Paris...	155¼	... 3 0	... 3	... 8	... 51·7
Orleans	Bordeaux (Bastide)—Paris	359	... 6 59	... 4	... 17	... 51·4
Nord...	Boulogne—Paris	158	... 3 5	... 1	... 5	... 51·3
Joint Service, Orleans, & Midi: (Included in above list)	Paris—Bayonne	486	... 8 59	... 6	... 24	... 54·1

Best Start-to-Stop Runs of French Expresses.

	Miles.	h. min.	Speed. Miles per hour.
Nord:			
Paris—Amiens	81¾	1 21	60·5
Paris—St. Quentin	95¾	1 40	57·4
Amiens—Calais Pier	104	1 49	57·2
Longueau—Paris	79	1 24	56·4
Arras—Longueau	41¼	0 44	56·2
Paris—Longueau	79	1 25	55·8
Paris—Busigny	113	2 2	55·6
Paris—Arras	120	2 10	55·5
Amiens—Paris	81¾	1 30	54·5
Paris—Amiens	81¾	1 30	54·5
Longueau—Paris	79	1 28	53·8
Calais Pier—Amiens	104	1 57	53·3
Abbeville—Boulogne	49½	0 56	53·0
Longueau—Creil	47½	0 54	52·8
Compiegne—Paris	52¾	1 0	52·7
Longueau—Arras	41¼	0 47	52·6
Paris—Longueau	79	1 30	52·6
Abbeville—Amiens	28	0 32	52·5
St. Quentin—Paris	95¾	1 50	52·2
Boulogne—Abbeville	49½	0 57	52·1
Busigny—Paris	113	2 10	52·1
Calais Pier—Amiens	104	2 0	52·0
Amiens—Calais Pier	104	2 0	52·0
St. Quentin—Jeumont	52	1 0	52·0
St. Quentin—Paris	95¾	1 51	51·8
Longueau—Arras	41¼	0 48	51·6
Arras—Longueau	41¼	0 48	51·6
Arras—Longueau	41¼	0 48	51·6
Paris—Amiens	81¾	1 35	51·6
Longueau—Creil	47½	0 55	51·4
Amiens—Boulogne Ville	76½	1 30	51·2
Boulogne-Ville—Amiens	76½	1 30	51·2
Boulogne—Abbeville	49½	0 58	51·2
Amiens—Abbeville	28	0 33	50·9
Arras—Douai	16	0 19	50·5
Douai—Arras	16	0 19	50·5
Paris—St. Quentin	95¾	1 54	50·4
Amiens—Calais Ville	102½	2 2	50·4
Paris—Creil	31¾	0 38	50·4
Creil—Paris	31¾	0 38	50·4
St. Quentin—Aulnoye	38½	0 46	50·2
Amiens—Creil	50	1 0	50·0
Tergnier—Amiens	50	1 0	50·0
Paris—Longueau	79	1 35	50·0
Orleans:			
Orleans—Tours	69¾	1 12	58·1
Angouleme—Bordeaux	87	1 31	57·3
Bordeaux—Angouleme	87	1 31	57·3
Poitiers—Angouleme	70¼	1 14	57·0
Angouleme—Poitiers	70¼	1 15	56·2
Poitiers—Tours	62½	1 7	56·0
Paris—Orleans	73¾	1 20	55·3
Orleans—Tours	69¾	1 16	55·1
Tours—Poitiers	62½	1 8	55·1
Angouleme—Bordeaux	87	1 36	54·4
Tours—Orleans	69¾	1 17	54·3
Tours—Orleans	69¾	1 17	54·3
Poitiers—Angouleme	70¼	1 18	54·0
Orleans—Paris	73¾	1 22	54·0
Bordeaux (Bastide) — Angouleme	82¾	1 32	54·0
Angouleme—Poitiers	70¼	1 19	53·3
Poitiers—Tours	62½	1 11	52·8
Tours—Orleans	69¾	1 20	52·3
Paris—Orleans	73¾	1 25	52·1
Tours—Poitiers	62½	1 12	52·1
Orleans—Paris	73¾	1 26	51·4
Bordeaux—Angouleme	87	1 42	51·1
Angouleme—Poitiers	70¼	1 24	50·2
Poitiers—Tours	62½	1 15	50·0
Midi:			
Morcenx — Bordeaux Controle	67¾	1 6	61·6
Morcenx—Dax	24¼	0 25	58·2
Morcenx—Bordeaux Controle	67¾	1 10	58·1
Dax—Bayonne	31	0 33	56·3
Bayonne—Dax	31	0 33	56·3
Bordeaux—Morcenx	67¾	1 12	56·2
Bayonne—Dax	31	0 34	54·7
Dax—Morcenx	24¼	0 27	53·9
Dax—Morcenx	24¼	0 29	50·2
Ouest:			
P.L.M.:			
Paris—Rouen	86¾	1 42	51·0
Dijon—Laroche (3)	99½	1 59	50·1
Est:			
Paris—Rheims	96¾	1 56	50·0

Next I give a list of some actual performances at the fastest of these bookings, only runs booked at 55 miles and upward being included. At speeds between 50 and 55 miles an hour I have notes of many runs with loads of 200 to 340 tons, time being usually gained and in no case lost in the running. In every case the work was done by *one* engine, pilots not being employed in a single instance.

Actual Performances.

	Miles.	Min.	Load, excluding engine and tender, English tons.
Nord:			
Paris—Amiens	81¾	76½	148
Paris—Amiens	81¾	79½	179
Paris—St. Quentin	95¾	85¼	115
Paris—St. Quentin	95¾	91	120
Paris—St. Quentin	95¾	94	178
Paris—St. Quentin	95¾	95	200
Calais Pier—Amiens	104	99½	135
Longueau—Paris	79	79½	200
Arras—Longueau	41¼	40¼	200
Paris—Longueau	79	80¾	165
Paris—Busigny	113	116¼	200
Paris—Arras	120	122	165
Boulogne—Amiens	77	72½	134
Orleans:			
Orleans—Tours	69¾	67½	131
Orleans—Tours	69¾	72	193
Angouleme-Bordeaux	87	85¼	131
Angouleme-Bordeaux	87	89½	170
Bordeaux-Angouleme (Bastide)	82¾	84	200
Poitiers — Angouleme	70¼	73½	131
Poitiers — Angouleme	70¼	75	193
Angouleme — Poitiers	70¼	77	200
Poitiers—Tours	62½	69½	200
Paris—Orleans	73¾	75¾	131
Paris—Orleans	73¾	82¼	193
Tours—Poitiers	62½	68	193
Tours—Poitiers	62½	67	131
Midi:			
Morcenx—Bordeaux	67¾	64¾	130
Morcenx—Dax	24¼	25	130
Bordeaux—Morcenx	67¾	69¾	131
Bordeaux—Morcenx	67¾	70	130
Dax—Bayonne	31	34	131

The only British bookings at 55 miles an hour from start to stop are the following:—

Railway.	Stations.	Distance.	Time. h. min.	Speed.
Cal.	Forfar—Perth	32½	0 33	59·1
,,	Stirling—Perth	33	0 35	56·5
,,	Perth—Aberdeen	89¾	1 37	55·6
N.E.	York—Darlington	44¼	0 48	55·3
G.N.	Peterborough—Finsbury	73¾	1 20	55·3
G.N.	Hitchin—Huntingdon	26¾	0 29	55·3

It must be confessed that the contrast is somewhat depressing from a British point of view.

COLD WEATHER AND FIRE OUTBREAKS.—In an article on the outbreaks of fires in cold weather, which appeared in the *Lancet*, the writer calls attention to the coincidence of the recent outbreaks of fires with the severe cold "snap" which was experienced. There are one or two factors which occur to us which may play an important part in rendering the outbreak of fires more probable on the onset of a cold dry season than at other times, says our contemporary. First, may be placed the increased use of appliances for domestic heating, with, therefore, correspondingly increased chances of material being ignited. While this is so, it must be remembered also that the onset of keen dry air tends to render combustible material more inflammable by making it drier. Further, the absence of moisture in air undoubtedly favours the progress of combustion, and the specific heat of dry air compared with moist air is, comparatively speaking, nil. Again, moisture is a diluent, so to speak, playing no part in combustion. It is a matter of common observation that the glowing end of a recently-extinguished wooden match continues to glow more brightly and for a longer time in keen dry air than in warm moist air, resembling in this respect the old experiment of dipping the glowing end into oxygen. This cannot be explained by assuming that the air contains any greater percentage of oxygen, although relatively the quantity of oxygen must be greater in cold dry air because of its increased density compared with warm air. Whatever may be the explanation, it is certainly remarkable that big outbreaks of fire so often occur simultaneously with the advent of cold dry easterly winds.

HYDRAULIC TURBINES, MILAN ELECTRICITY WORKS

RIVA AND MONNERET, MILAN, ENGINEERS

(*For description see page 621*)

Fig 4.

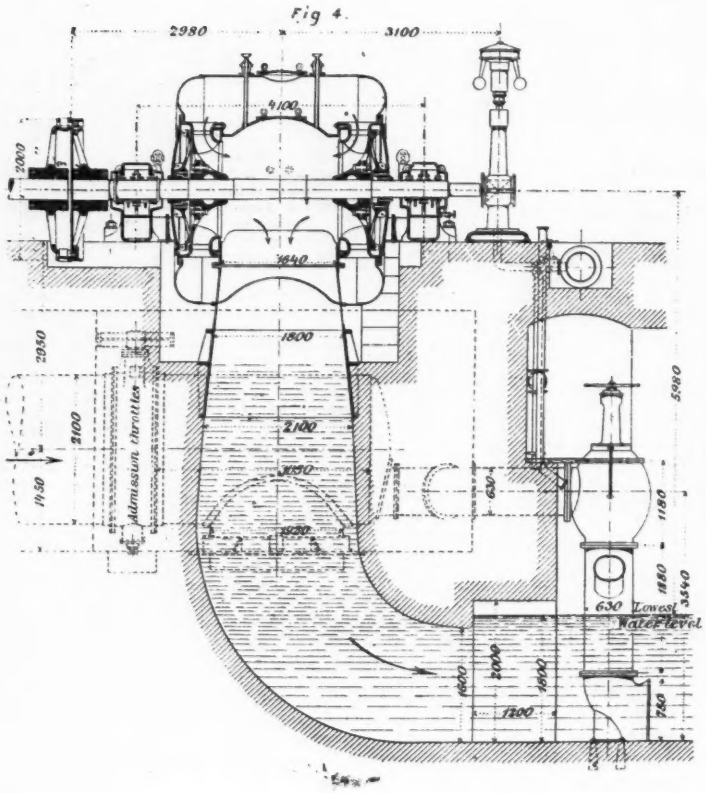


Fig 5.

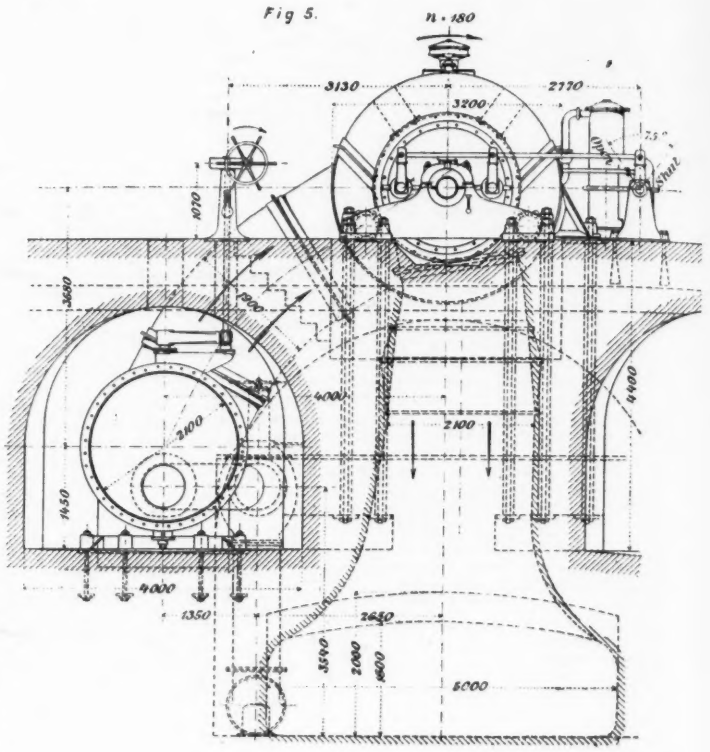


Fig 7.

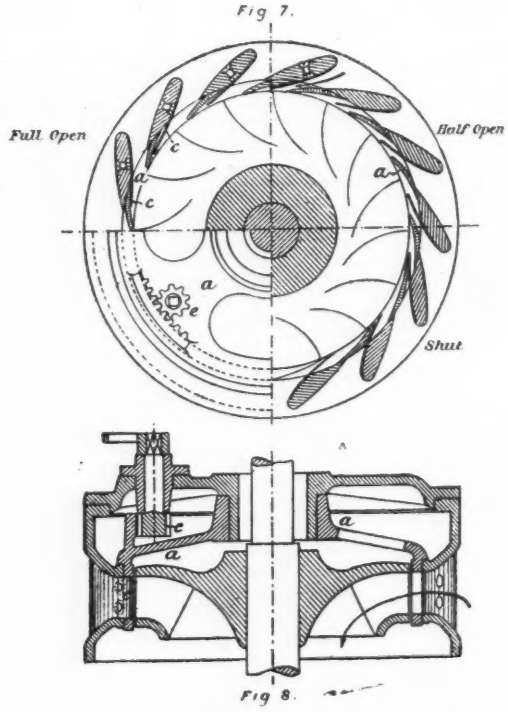
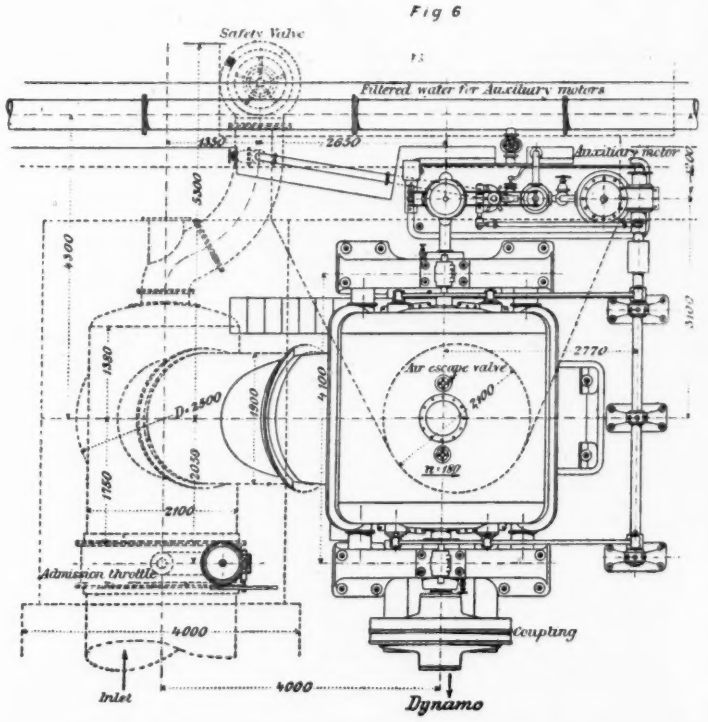


Fig 8.

Fig 6



NEW PLANT FOR THE CANE SUGAR INDUSTRY.

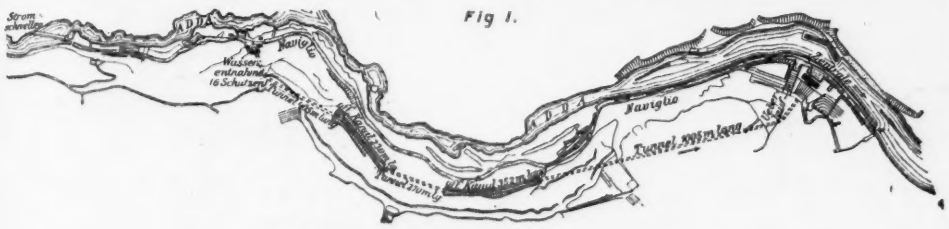
THE late hurricane in Porto Rico caused great damage to all the sugar estates in that island, and a number of the estate working plants were levelled to the ground. Three of these damaged estates are now being amalgamated to make a central sugar factory, and the work of equipping them has been entrusted to McOnie, Harvey, and Co., Limited, Glasgow. This firm has just completed some specially heavy cane-crushing machinery for the Penang Sugar Estates Company, of London and Penang, of which Sir John W. Ramsden, Bart., of Huddersfield, is the proprietor. The machinery consists of two sets of re-grinding sugar-cane mills, the rollers being 36in. diameter by 6ft. long. These are fitted with steel shafts of extra strength, the journals being 17in. diameter by 24in. long, and are carried on extra heavy side frames, which have through side and main top bolts of heavy section of steel, the latter so arranged as to give the narrowest possible return plate. The returner is of the rocker type, and consists of a deep beam of cast steel, supported on strong brackets from the bottom of the bed-plate up through the side frames. The rollers run in heavy gun-metal bearings, which are cast hollow for the purpose of water circulation, thus assisting to keep the bearings cool, which is a consideration, owing to the great pressure now exerted by these large mills so as to extract all the juice out of the cane. The mills are fitted with strong self-acting carriers for feeding the canes into the mill, and mechanical carriers for removing the crushed cane to the steam boilers. The mills are driven by powerful horizontal engines of the Corliss frame pattern, having piston valves, the steam cylinders being 28in. diameter by 48in. stroke, and fitted with link-reversing motion, and sensitive high-speed governors. The fly-wheels are heavy, and built of centre arms and segments, for shipment abroad. These engines transmit their power to the mill through strong double gearing, all the spur pinions and the large pinions on the roller shafts being of the best Siemens cast steel; the main and intermediate spur wheels are built, and the segments are also of cast steel, the shafts being of best forged steel and of large proportions, suitable for the work required. The whole of this cane-crushing machinery, as erected in McOnie, Harvey, and Co.'s works, has recently been inspected by Sir John Ramsden, along with Mr. Arnold, the secretary, and Mr. Turner, the Sugar Estates Company's administrator in Penang. McOnie, Harvey, and Co. have also in progress another powerful plant, the first of several to be erected for the Straits Sugar Company, Limited, a concern in which the above-named gentlemen are also interested, consisting of engine, mill, and gearing. This plant, while mainly a duplicate of that already noticed, is for the manufacture of what is called in the Straits, "Basket sugar," or Muscovado. In place, however, of the usual copper wall used generally in the manufacture of this quality of sugar, Mr. Turner intends using a Harvey triple-effet evaporator, which will effect a saving in fuel and labour, as well as an improved recovery of sugar. After the syrup is brought to a high density, it is treated in a special manner by a patent process of Mr. Miller, the chemist of the company in Penang. By the Miller process the syrup is kept at a low temperature, so that there is no danger of its being charred, as sometimes occurs in the usual copper wall. Thus all the water is taken out of the syrup at a low temperature, and it is then run into another vessel, where it is kept in motion until it granulates into a mass of raw sugar, and is used in this state by the natives in the East, or sold to refiners and brewers. The advantages claimed for the process are that no molasses are produced, that the sugar will give a high recovery, and with the low temperature at which the juice is treated in the triple effet, and in Miller's patent granulators there will be less loss from inversion, as compared with the present system of making Muscovado sugar on the copper wall with open evaporation. Also the process is simple, as no vacuum pans nor centrifugals are required.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineers: J. J. Walker, to the Hotspur; Thomas G. Coomber, to the Pembroke, additional for charge of the floating factory, Chasseur. Chief engineer: John T. H. Ward, to the Pembroke, additional for the Northumberland. Assistant engineer: H. E. Nicholls, to the Vivid, supernumerary.

THE MILAN ELECTRIC POWER AND LIGHTING WORKS.

THE tramway system of the city of Milan has, under the auspices of the Edison Electric Company, been completely rearranged, the cars being now worked by current brought from a hydraulic power station at Paderno, on the Adda, about twenty miles above the city, by overhead conductors, at the unusually high tension of 13,000 volts. The works, which have been described in detail by Professor Ugo Ancona, in the columns of our contemporary the *Zeitschrift des Vereines Deutscher Ingenieure*, include a head generating station for the high-tension current, an intermediate transformer and auxiliary steam powers tation at the Porta Volta at the city boundary, giving current at 3500 volts, and a central transformer station at Santa Radegonda, near the Cathedral Square, giving direct current at 550 volts for the tramways and 110 volts for lighting purposes, each of which will be briefly noticed.

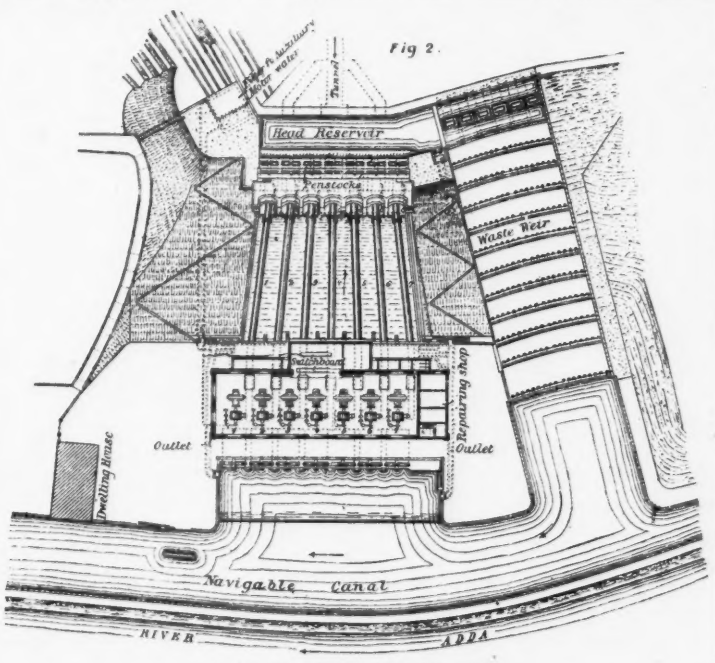
Fig 1.



MILAN ELECTRIC POWER STATION ON THE ADDA

The principal power station is situated at Paderno, on the Adda, a short distance below the weir supplying the Naviglio—see Fig. 1—an existing navigable channel, from which the power water is taken through a head sluice with six iron penstocks, by a conduit, including a tunnel of 405 m., followed by an open cut of 230 m., a second tunnel of 270 m., a second cut of 352 m., and a final tunnel of 1005 m., to the service reservoir of the station, where a head of 29 m. is obtained. The conduit is lined with concrete through its whole length of 2268 m. (7446ft.), and delivers 45 cubic metres (nearly 100,000 gallons) of water per second, the rate of flow being 2·7 m. per second. This corresponds to about 17,000 gross, or, at a yield of 75 per cent., 13,000 effective horse-power, which, divided over six groups of motors, gives 2160-horse power for each unit.

Fig 2.

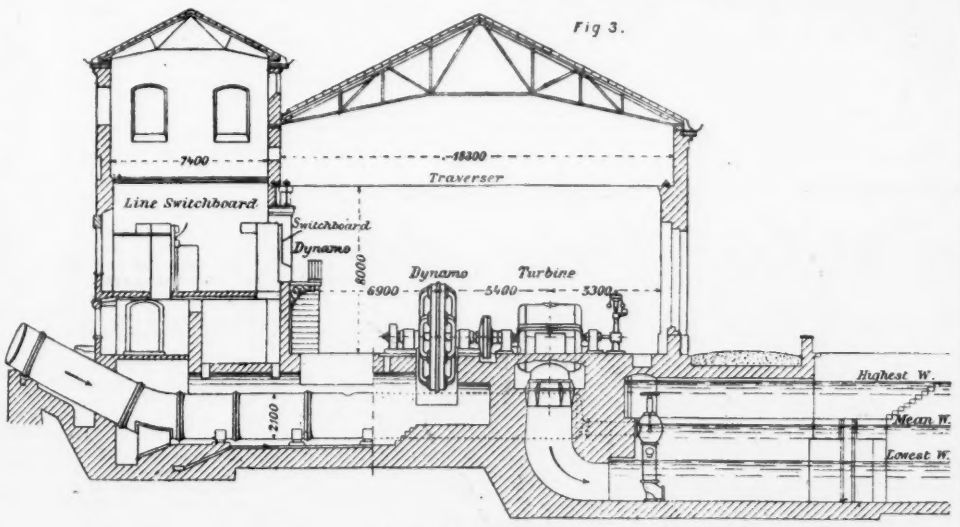


PLAN OF POWER STATION—MILAN

The arrangements of the power stations are shown in Figs. 2 and 3. From the head reservoir, tubes of half-inch steel plate, 82⅝in. in diameter, lead the water to the seven groups of turbines, one of which is kept constantly in reserve, the levels being so arranged that the engine-room floor is about 4½ft. above the highest flood level in the tail race. At the side of the reservoir a stepped waste weir has been provided of sufficient size to allow the water to flow quietly into the canal in the event of the whole of the wheels being suddenly stopped. On the opposite side there is a small filtering basin for supplying clean water to the hydraulic regulator. The turbines, which, with the exception of those at Niagara, are the largest existing motors of their class, have been built by Messrs. Riva and Monneret, of Milan, from designs selected in a competition in which Escher Weiss and Co., of Zurich, Piccard and Pictet, of Geneva, Ganz and Co., of Buda Pest, and the makers took part. They are of the tangential central discharge class, with bucketed wheels arranged in pairs upon a horizontal shaft, receiving the water on the circumference, and discharging inwards, whereby end thrust on the shaft is prevented—see Figs. 4, 5, and 6, page 620.

On account of the variation of the water level in the river at different times of the year, the wheels are arranged to run under a constant pressure head of 23 m., the remaining fall, which seems to vary about 7 m. between highest and lowest water, acting by suction. The regular speed is 180 revolutions per minute, the external diameter of the guide wheels being 1920 mm. Extreme regularity of working being required, the highest permissible variations of speed are 2 per cent. in ordinary work and not more than 4 per cent. when the load is suddenly increased or diminished by 25 per cent. This is effected by the arrangement shown in Figs. 7 and 8. A movable ring *a* carries a series of tongues, which, by motion in either direction, expand or contract the area of the admission channels, without altering the direction of the water, the passages being shut when the tongues are in contact with the fixed plates *c* at the back of the guide blades. The ring is controlled by Ganz and Co.'s well-known hydraulic governor, Fig. 9, which is an auxiliary hydraulic engine with two pistons, *a* and *b*, carrying a racked rod *d*, which works on the toothed sector *e*, Fig. 7, the admission valve being governed by the centrifugal regulator. The return rod *f* provides an independent control on the admission, to prevent over-governing. In addition to this arrangement, a second regulator, on Siemens principle, is provided in the shape of a small electro-motor, which can be moved in either direction by current from the switchboard, whereby the condition of equilibrium of the governor is changed by turning the auxiliary balance spring about its point of suspension at *i*. As these motors can all be brought into action at once, it is possible to alter the speed of the whole of the wheels simultaneously, an arrangement which has been found to be extremely useful when working in parallel. Three of the turbines have been at work for about six months, and, according to careful observations, give a useful effect of about 82 per cent. At times they have been run at 300 revolutions per minute without any derangement either of the mechanical or electrical parts. Each turbine is connected by an elastic coupling to a dynamo—Figs. 10, 11, 12, page 620—which, at 180 revolutions, gives tri-phased alternating currents of 13,500 volts and 42 periods per second. The exciters are carried on the same shaft as the field magnets, an arrangement adopted for simplicity, although open to the objection that the tension of the current is subject to variation with the speed of revolution. The fixed armature of 4·1 m. internal diameter is not, as usually done, attached to the foundation plate, but is connected by cylindrical surfaces to the main bearing on either side, an arrangement which gives a safe and perfect method of centering. The field magnets are carried on a steel fly-wheel, cast in one piece, with twenty-eight poles built up of sheet iron; the windings are in flat copper, 3 by 32 mm., with paper insulations. The high-tension current passes by cables below the floor to the engine-room switchboard and line, and thence to the main line to Milan. This is intended to have six groups of conductors, each of three wires of 9 mm. diameter, but only three have as yet been erected. They are carried on posts of section iron 10 m. high, placed 60 m. apart, a wayleave rent being paid by the company for the use of the ground traversed. Lightning protectors, both of Wurts' and Siemens' construction, are under trial experimentally.

Fig 3.



MILAN POWER STATION

The Edison Company pay the town 4500 lire per kilom. (£288 per mile) per annum for rent and maintenance of the new line, the overhead electrical lines being the property of the company, which is allowed out of the receipts 25 centimes for each motor car, and 13 centimes for each trailer car per kilom. run, the balance being divided in the proportion of 60 per cent. to the town and 40 per cent. to the company. The tramway traffic in Milan is very considerable, and is rapidly increasing, considering that the population is below half a million. The number of passengers carried in the month of December, 1898, was 4,196,059, or an average of 135,537 per diem. In the present year there has been a further large increase, owing to the introduction of a system of half fares—5 centimes instead of 10 centimes—between 7 a.m. and 9 a.m.

NEW CUNARD STEAMER SAXONIA.

THE new Cunard liner Saxonia, launched from the Clydebank Works of John Brown and Co., Limited, on Saturday, 16th inst., is, in point of gross tonnage, the largest vessel ever built on the Clyde. In respect of length, elaborateness of internal fittings, and probably in weight of structure, as well as of propulsive power, she is, of course, behind the former Fairfield-built Cunard greyhounds—the Campania and Lucania. She is, however, with her sister ship Invernia, launched on the 21st September last, from the yard of Messrs. Swan and Hunter, on the Tyne, representative of the development which has been going on for some years in the calling into existence of vessels intermediate between the high-speed purely passenger "greyhound" and the capacious, slow-going "beast of burden."

The Saxonia and her sister are designed primarily to be large cargo carriers, passenger carrying being subordinate to that requirement in so far, at least, as speed of passage is concerned. Nevertheless, these new vessels have excellent accommodation for passengers of both first and second class, and for a very large number of steerage passengers. Where there is no feverish desire on the part of ocean travellers to save an hour or two, or a day, in making the passage—regardless of paying highly for this requirement—the intermediate vessels, of which the Saxonia and the Invernia are splendid examples, and the first in the Cunard fleet, are no doubt efficiently meeting a want in ocean travel, and fulfilling a trying condition of modern shipping economics.

The gross tonnage of the new Cunarders—which are the largest of the intermediate class of ocean steamships yet built—is close on 14,000 tons, and they rank in this respect amongst the first ten steamers of all classes in the world. In our issue for September 22nd an illustration of the Invernia as she will be completed and *en route* at sea was given. The dimensions of the Saxonia, which will, of course, be propelled by twin screws, are not, except as regards length, precisely those of the Invernia, and in what follows the Saxonia only is referred to:—Length between perpendiculars, 580ft.; length over all, 600ft.; breadth extreme, 64ft. 3in.; moulded depth from upper deck, 41ft. 6in. The hull is constructed of mild steel, of scantlings somewhat in excess of the requirements of Lloyd's Register for the highest or 100 A1 class. The hull is subdivided transversely into eleven water-tight compartments, in addition to the elaborate subdivisioning of the double bottom; all this being such that the vessel will be unsinkable except in the extreme case of penetration into a number of separate compartments simultaneously. To afford ample provision for sufficiently immersing the vessel when on her western, and therefore relatively light draught passage, the vessel is fitted

MILAN ELECTRICITY WORKS—HYDRAULIC GOVERNOR AND DYNAMO

(*For description see page 621*)

Fig 9.

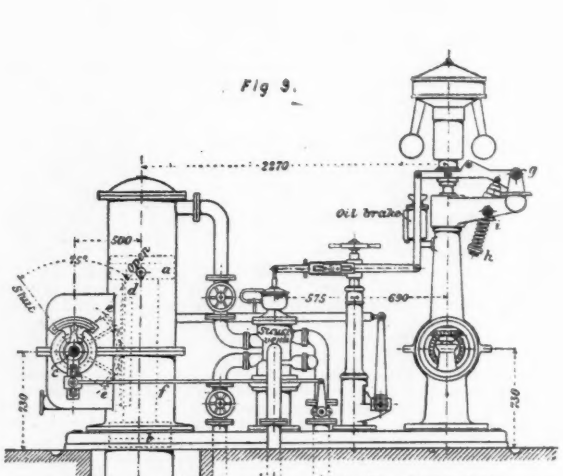


Fig 10.

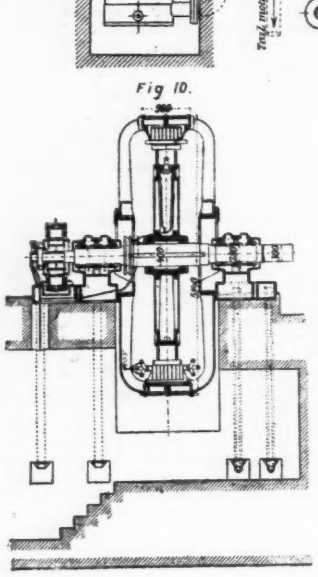


Fig 11.

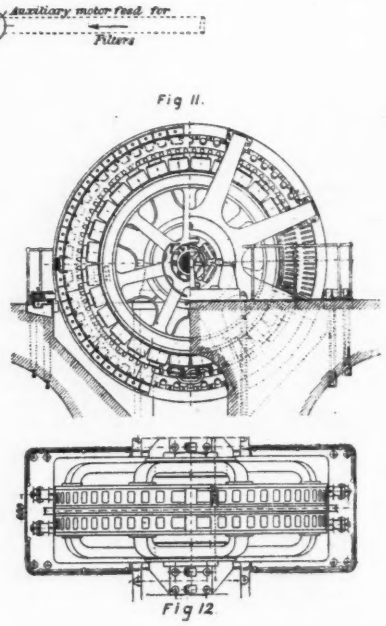
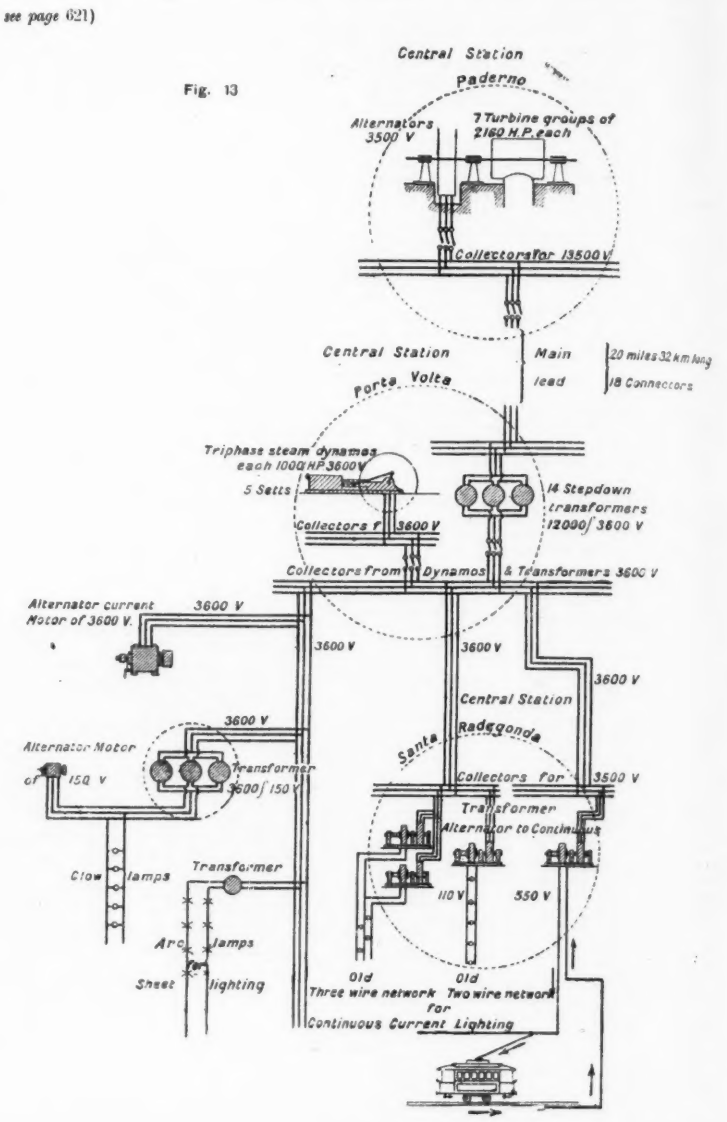


Fig 12

Fig. 13



with deep water ballast tanks in addition to the extensive ballast compartments of her double bottom ; a total capacity of about 4500 tons being thus provided.

There are four principal decks—lower, main, upper, and shelter decks, the latter being an entire deck, and having over it, for 280ft. of its length amidships, a bridge deck with large deck-houses superimposed. Below the lower deck, forward of the boiler compartment, there is an orlop deck to the collision bulkhead forward. On the main deck forward accommodation is provided for a very large number of third-class passengers, there being three rows of state-rooms on each side to accommodate each four persons, the central part being open for dining a large body of passengers. The whole of this accommodation is fitted so as to be readily removed in the event of the space being required for cargo. When the vessel does carry third-class passengers, these, as a result of the immense resources of the vessel's arrangements, have comforts and conveniences beyond what is customarily afforded them in the high-speed and more crowded mail and passenger steamers. On the upper deck they have a promenade, with lavatories, bath-rooms, &c., while on the shelter deck, still higher, there is a smoking-room and ladies' room. For second-class passengers, should the owners deem it expedient to make provision at any time for carrying this class, considerable space has been reserved on the shelter deck aft. The accommodation for 165 first-class passengers is in the large deck-house over the bridge-deck. Above this deck-house is still another deck, on which the boats are carried, and on which the passengers can promenade. Here also is the library and other public-rooms for the first-class passengers, and at the forward end the captain's cabin, having over it the navigating bridge, at an altitude sufficiently imposing. The first-class dining saloon, in which 150 passengers can be seated comfortably, is on the shelter deck, and is lighted and ventilated by a large and handsomely decorated dome skylight and by large opening side ports.

Below the orlop deck, forward, are insulated compartments for the carriage of chilled meat, three refrigerating engines fitted above supplying the cold air for this purpose. The whole of the upper deck at the after end will be fitted for the safe carriage of horses and cattle. The great cargo holds of the vessel generally occupy the remaining parts of the vessel below the upper deck, both fore and aft. The four masts, with a large number of derricks, are so placed and fitted, relatively to the hatches, that the work of discharging will be carried out with the greatest expedition. The latest pattern appliances in the way of capstans, warping, and cargo winches, steering gear, &c., form part of the deck equipment, and the vessel is, of course, lighted throughout by electricity.

The propulsive machinery of the Saxonia, of which more may be said later, consists of two sets of balanced four-cylinder quadruple-expansion engines designed to indicate about 10,000-horse power. These drive twin propellers, three-bladed. Steam at 210 lb. pressure will be supplied from nine single-ended Scotch boilers, worked under forced draught on the Howden system. On the measured mile a speed of somewhat over 16 knots is expected, her speed on ordinary service at sea having to be about 15 knots.

The Saxonia was sent off the stocks at Clydebank about 11.30 on the 16th inst., the Hon. Mrs. G. A. Burns performing the christening ceremony.

After the launch the builders entertained the invited guests at luncheon, most of the directors being present—Mr. J. D. Ellis presiding. In proposing "Success to the Saxonia," and in making his first public appearance at Clydebank, the chairman had something to say about his firm of John Brown and Co., Limited, having become the proprietors of the Clydebank shipyard and engine shops. For the last forty years they had been manufacturers at Sheffield of ship plates, shafting, and armour plates, and, as a matter of fact, had been making armour plates for a longer period than any other firm in Sheffield. Some of their competitors had found it advisable to join with shipbuilders, and as John Brown and Co., Limited, had no desire to be behindhand, they followed the example thus set. They had an excellent offer from the Clydebank Engineering and Shipbuilding Company, who all through had treated them most honourably, and they accepted it. The amalgamation of interests would be beneficial to John Brown and Co., and he trusted it would also work to the benefit of Clydebank. He did not wish to convey the impression that the Clydebank Company would cease to order much of its material from Clyde makers, but they could perhaps understand how great an advantage it would be to be able to fall back on the resources of Sheffield on any occasion when there was difficulty of obtaining material in the Clyde district.

The Hon. G. A. Burns, in replying to the toast, said the Saxonia and her sister, the Ivernia, were good and useful, and likely to be profitable ships in their trade. With the need for fast troopships, likely to be greater soon, the Saxonia supplied an object-lesson of what the British shipowner could really do at a pinch. If the Government wished her, the latest Cunarder could be fitted out for the conveyance of troops very rapidly, and she could be made to accommodate 2000 infantry, a regiment of cavalry, and a battery of artillery. The Saxonia was the twenty-ninth vessel built for the Cunard Line by the firm which was now John Brown and Co, Limited. The connection covered a period of over fifty years. In replying to the toast of "The Builders," Mr. C. E. Ellis said they valued to the fullest extent possible the connection which the Clydebank Company had with the Cunard Line and with similar concerns in the mercantile and naval world, and no effort would be spared on the part of the directors to maintain the high standard of efficiency and workmanship which had prevailed for so many years.

THE LAUNCH OF THE S.S. PARKSIDE.

THE launch of the s.s. Parkside from the Foyle Shipyard of the Londonderry Shipbuilding and Engineering Company, last Saturday, was an event of considerable local importance for more reasons than one. In the first place, the yard had been for some time closed before being taken over by this company, and naturally the re-opening of it has found work for a large number of hands. Then, too, the Parkside was the first vessel launched by this company, and it was carried out without a hitch ; and lastly, the boat is of considerable size, having been designed to carry a deadweight load of 6200 tons. The yard at the present time employs some 400 men, which will no doubt be increased if the company intends to live up to the whole of its title. At the present time it does not construct the engines or boilers for the vessels it builds, but this, we understand, it soon proposes to do.

The dimensions of the Parkside are 372ft. over all, 46ft. 3in. broad, and 28ft. 6in. to the upper deck beams. She has been constructed to Lloyd's highest class—100 A1. She has poop, long bridge and forecastle, and is provided with a large capacity for water ballast in a double bottom which extends the full length of the vessel. She is also arranged for water ballast fore and aft. Her gross register tonnage is 3680 tons. There are two complete steel decks running the whole length of the ship, and five large hatchways, which are served by ten derricks. Four of these are stepped on each mast and two on crane posts which have been introduced on the bridge deck. She has also seven powerful steam winches. The holds are subdivided by six water-tight bulkheads, and arrangements have been made for the carriage of large grain cargoes in bulk. The engines will be triple-expansion, with cylinders 24½in., 40in., and 67in., by 45in. stroke; made by Dunsmuir and Jackson, of Glasgow. There will be two boilers, which will work at a pressure of 180lb. on the square inch. The heating surface is 4500 square feet. The shaft and propeller were, of course, fitted before the vessel left the ways. The vessel will be rigged as a two-masted fore-and-aft schooner.

The launching ceremony was performed by the Duchess of Abercorn, and the Parkside went easily down the ways on to a full tide. She was quickly brought up and taken to the finishing jetty of the company.

AT a meeting of the Birmingham Association of Mechanical Engineers held on Saturday, a paper was read by Mr. W. H. Thornbery on "The Distribution of Power in Mills and Factories." He said the object was to deliver at the actual point where the work had to be done the greatest amount of power generated, whether it was by means of coal, gas, or electricity. The power absorbed, due to the methods adopted of driving the machinery, was as much as 66 per cent. of the brake horse-power of one engine which occurred in an old factory. In a modern manufactory the loss of energy was but 9 per cent.

RAILWAY MATTERS.

TWENTY-TWO thousand four hundred and ten tons of 80 lb. and 90 lb. rails have been laid on the Erie Railroad during the year ended June last.

THE death occurred on Friday, at Cirencester, of Mr. Edmund William Cripps, chairman of the Midland and South-Western Junction Railway. He was fifty-seven years of age.

THE Scarborough Corporation will promote a Bill in the next parliamentary session for the construction of a tramway along the Foreshore-road, the new marine drive now being formed, and the Royal Albert drive.

THE first Corean railway was opened to traffic on September 18th. This is the Kyeng-in Railway, between Seoul and Chemulpo, the track being laid to within five miles of Seoul. It is of standard gauge, and is 26¼ miles long.

IN the Parliament of the Swiss Confederacy recently, after a discussion over the legal length of a day's work by railway employés, it was fixed at a maximum of eleven hours by a vote, however, of fifty against forty-eight, who favoured a ten-hour day.

A GAS engine, said to be the largest in the world, is now being made by the Westinghouse Company, East Pittsburgh. The engine will be of 1500-horse power. Its cylinders are 34in. by 60in. The extreme length of the engine is 44ft.; width, 12ft. 4in.; and height over all, 27ft.

THE Board of Trade have recently confirmed an order authorising the construction of light railways in the county of Kent between Cranbrook and Tenterden, in extension of the Rother Valley (Light) Railway, and the construction and working of that railway as a light railway.

A SPECIAL meeting of the Batley Town Council was held last week to formally approve the intention of the Corporation to apply to the Board of Trade for a provisional order under the Tramways Act, authorising the Corporation to construct electric tramways in the borough. The resolution was carried.

AN accident of a serious nature, by which nineteen persons were injured, occurred at Crewe on Thursday, the 14th inst., to a London and North-Western train from Hereford and Shrewsbury. Owing, it is stated, to the brakes not acting properly, through the frosty state of the rails, the train ran into the stop blocks at the end of the bay.

DURING September the number of railway accidents in the United States was 231, including 116 collisions, 110 derailments, and five other accidents, causing the death of 93 persons and injuring 226. Five accidents were due to defects of road, 42 to defects of equipment, 62 to negligence in operating, 11 to unforeseen obstructions, and 110 are "unexplained."

THE Great Central Railway Company is applying to Parliament next session for powers to create and issue a second debenture stock to an extent not exceeding £6,000,000. The new stock is to bear interest at a rate not exceeding 3½ per cent. per annum, and it will be expressly provided that it shall rank after the existing debenture stock of the company, and after any debenture stock which they are now, or may be hereafter, authorised to create or issue.

ON Sunday night the two expresses which run between Bordeaux and Paris with an interval of seventeen minutes collided between Montmoreau and Charmant. The first train, which leaves Bordeaux at half-past ten, came to a standstill some distance from Charmant Station. The train was late, and the second express, following at a short interval, dashed into its rear with terrific force. Several coaches and post-office vans were completely smashed, one passenger was killed and several injured.

THE Board of Trade have informed Mr. J. E Ellis, M.P., who has taken an interest in the question of the date of issue of railway companies' time-tables, that in future time-tables will be issued five clear days before they are to come into operation. The Railway Companies' Association have, within the last few weeks, informed the Board that this arrangement has been made as the result of the meetings held by the general managers of the various railway companies to consider the matter.

AN accident, which resulted fatally to two passengers, and caused considerable inconvenience to Metropolitan Railway travellers, occurred on Tuesday morning at Bermondsey, on the London, Brighton, and South Coast Railway. While a South London train was standing near the Spa-road signal box, a train from Oxted and Croydon, coming in the same direction, missed the signals, owing to a prevailing fog, and collided with the former, wrecking the rear coach. The guard of the Oxted train was seriously injured, and several passengers also complained of injuries.

THE Dewsbury Corporation have come to terms with the British Electric Traction Company, and have, therefore, withdrawn their own application to the Board of Trade for powers to construct tramways within the borough, and will support the company. Under the agreement the Corporation will supply the electric energy to run the cars, and they will also lay the metals on the route within their jurisdiction, the company paying a rent, and ultimately, after a term of twenty-eight years, which may be increased by two terms of seven years each, the local authority will become possessed of the lines.

THE train de luxe of the International Sleeping Car Company, the Calais-Mediterranean Express, which commenced the present season by running twice weekly, will in future run four times weekly, *i.e.*, on Sundays, Mondays, Wednesdays, and Fridays, and will, in addition to serving the usual towns on the French Riviera and Monte Carlo, continue on to Bordighera, Ospedaletti, and San Remo, without change of car from Calais, corresponding with the 9.0 a.m. trains from Charing Cross and Victoria. On the return journey the trains run direct from San Remo, &c., to the steamer at Calais.

A BILL for incorporating the Leeds City and Suburban Railway Company has been duly deposited for next session in the Private Bill Office of the House of Commons. By this Bill powers are sought to construct eight sections of railways, which taken together will form a line commencing by junctions with the Hunslet branches of the Great Northern and North-Eastern Railway and terminating at Shadwell. The aggregate length of these railways is given in the Bill at 9 miles 5·90 chains, and the route of the proposed line will be through Potternewton, Chapel-Allerton, and Roundhay, to Shadwell, where it will terminate at the west side of Hobberley-lane. The capital of the company is proposed to be fixed at £1,200,000.

ON Tuesday the Great Northern Railway Company was summoned by the London County Council for permitting locomotives to emit dense black smoke at the sidings, King's-cross. The proceedings had been taken in consequence of numerous reports which had been made by the inspectors of the London County Council. In July, 1898, notice was sent by the London County Council to the railway companies warning them against a breach of the Act, and, as that notice had failed to bring about the desired object, proceedings had been taken, in the first instance, against the Great Northern Railway Company. A County Council inspector having given evidence as to the emission of black smoke, and counsel for the company having announced that he was not in a position to disprove the allegations, the summons was adjourned.

NOTES AND MEMORANDA.

BY a decree of the Cretan Government an international exhibition is to be held at Canea next April.

A BILL concerning the theft of electric power by tapping of the wires has been laid before the German Federal Council.

THE percentage of unemployed members of the trade unions during November was lower than at any similar period since 1889.

THE new 30-knot torpedo destroyer Bittern underwent a successful steam trial in the North Sea last week, and is to be placed on the effective list as ready for commission.

THE German Schiffsbautechnische Gesellschaft has held its first meeting at Charlottenburg, near Berlin. It has 605 members, although it has been in existence only eight months.

THE present century has produced and consumed some nine million tons of copper, of which the last decennial period when it is closed will have taken probably over one-third, or three million tons of the metal.

AN International Congress of Methods of Testing Building Materials will be held in Paris next year between the 9th and 16th July. Particulars may be obtained from M. Baclé, the secretary, or from the Minister du Commerce, de l'Industrie des Postes et des Telegraphes, at the Exhibition Buildings.

THE Japanese Governor-General of Formosa has issued a decree fixing the amount of the tonnage tax to be paid by vessels in the foreign trade entering the open harbours of the island. Ships of European build have to pay 5 yen per register ton, and those of Japanese or Chinese build, from 3 to 5 yen, according to size.

THE Welsbach "master patent" for incandescent gas-light mantles expired last week. It is twelve years since Dr. Auer von Welsbach came before the world with his invention, which was described as "an illuminant appliance for gas and other burners, consisting of a cap or hood made of fabric impregnated with the substances mentioned, and treated as set forth."

MELINITE was originally picric acid, embedded in a collodion solution, and later on also fused picric acid. A mixture of fused picric acid and cresylic acid is now employed. Although picric acid was used as an explosive in the pulverulent state, mixed with saltpetre and other ingredients, yet the property of detonating with great violence when melted, was first indicated by Dr. Herman Sprengel, and afterwards patented by Eugéne Turpin, of Paris.

LYDDITE is simply picric acid brought into a dense state by fusion. The shells are coated inside with a special varnish, and the melted picric acid is cast into them. As this requires a strong detonator, or a very powerful primer, the Government is said to have adopted a primer of picric powder, which consists of a mixture of two parts of ammonium picrate to three parts of saltpetre, manufactured in much the same way as ordinary granulated gunpowder. This is then set off by the ordinary service fuse.

THE new shops of the Erie Railroad Company in Jersey City are driven by gas engines using producer gas. The producers are of the Taylor pattern, using rice coal—the smallest and cheapest size of anthracite—and the plant is a simple and compact one, taking up much less space, and requiring far less labour and attention, than would steam boilers furnishing the same power. The working of the plant thus far has been entirely satisfactory, and the records show a consumption of only 1·1 lb. of the rice coal per horse-power hour, while the average duty of the engines is equal to 22 per cent. of the theoretical efficiency of the fuel consumed.

IN the manufacture of artificial silk a pressure of forty to forty-five atmospheres is required to force the collodion from the reservoirs to the spinning machines, which are constructed with pipes running on each side. Into these pipes are screwed a number of taps, with a glass capillary tube fixed on the end, through which the collodion is forced. Immediately it comes into contact with the air it solidifies, enabling the operative to take hold of the thread or silk, as it can now be called, and convey it to the bobbin. After the silk has been dried it is very inflammable, and a process called denitration is next carried out, which re-converts the product into cellulose.

THE Corporation of Newcastle are experimenting with the incandescent gas light. Until recently the central space at Grey's Monument has been lighted by three electric lamps, each nominally of 1500-candle power, and costing £40 per annum, or £120 in all. The Gas Company has recently put up at the corners of the monument four lamp-posts, each carrying three lanterns fitted with two No. 4 Kern burners—a total of twenty-four burners. These have an average illuminating power of 2160 candles, as ascertained from actual tests made in the photometer room. The total estimated cost for gas supply, maintenance, attendance, &c., is said to be only £52 18s. 8d. per annum.

A MOTOR carriage has recently been introduced in France which is normally propelled solely by an oil engine, but on hilly ground is helped by an electric motor. The oil engine works at a constant speed, and when the vehicle does not absorb all the engine's power the excess drives the motor as a dynamo and charges accumulators. As the accumulators only have to supply power occasionally they are kept fully charged, and can therefore safely give rates of discharge which would seriously damage them if the cells were only partially charged. The engine is direct coupled to the dyna-momotor, which is shunt wound, and is used to start up the engine. The rate of charging can be adjusted by field regulation. Changes of speed are effected mechanically.

A NEW type of wheel for traction engines has been invented in America. Surrounding the hub of the wheel is a ring carrying rollers which bear upon the bottom of a groove formed in the hub. Arms pivoted to lugs on the outer side of the ring extend outward tangentially to the ring and carry at their free end blades which project through openings in the rim, and which adapt themselves to the nature of the ground. Springs are connected at their inner ends to the ring, and are adjustably secured at their outer ends to brackets on the rim. Should the wheel travel over hard ground the blades, as they engage the ground, will be forced inward, causing the ring to rotate on its bearing rollers. Upon reaching soft ground the blades will be moved outward by means of the springs, acting upon the ring, so that they will engage in the ground.

A RADIOMETER for measuring the heat radiation of the stars has been tested at the Yerkes Observatory. The instrument is the outcome of the work of Mr. E. F. Nichols, of Dartmouth College. It consisted of a suspension system formed of two mica discs, each 2 mm. diameter, blackened on the face, and supported by a light cross arm on either side of a thin glass staff, hung by an exceedingly fine quartz fibre in a partial vacuum. Both vanes were exposed to the radiation of the sky at the focus of a silvered glass mirror of 24in. aperture, fed with light by a siderostat outside. The rays entered the radiometer through a small window made of fluorite. With the apparatus so arranged, a deflection of 0·1 mm. would be given by a candle fifteen miles distant, neglecting loss by reflection and atmospheric absorption. The results obtained showed that stellar heat radiation was distinctly detectable.

MISCELLANEA.

ACCORDING to the *Figaro*, a navigation company has been formed in Paris for the establishment of a regular steamship service between Paris and London.

LAST Friday the first block for the Admiralty harbour works at Dover was successfully laid by Messrs. Pearson. The blocks weigh no less than 40 tons each.

THE Paris *Figaro*, referring to the proposal for the construction of a tunnel beneath Gibraltar, says that the British perceive that the undertaking is destined to succeed, and they are beginning to attack it.

THE White Star liners Britannic and Cymric have been chartered by the Government for transport service. They will be utilised at once to take out the drafts of the additional forces now being raised for South Africa.

AT a meeting of the Mersey Docks and Harbour Board held on the 14th inst., Mr. John Brancker, who has been a member of the Board for twenty-nine years, during nine of which he has acted as chairman, formally intimated his retirement.

THE Houlder Line steamship Royston Grange, which left Newport on November 22nd, and passed St. Vincent on the 30th, entered the Buenos Ayres Dock on the morning of the 13th inst., making the passage in the remarkably short time of twenty-one days.

THE use of horseless vehicles in municipal work has been brought to the notice of the Birmingham Health Committee, who are considering the expediency of adopting them for the Interception Department, which now employs a large number of horses, particularly at night.

IT is understood that the consideration of the applications recently received by the Bombay Municipality for concessions to lay cables under the streets of the city, in connection with a central electric supply station, has been deferred to afford other firms of standing an opportunity to send in their applications.

THE system of sewage disposal adopted by Truro Corporation is the aërobic bacterial oxidising process of the International Purification Syndicate. The cost is estimated at £1700, which, with contingencies, is expected to reach £2000. On Monday the Council met to consider the adoption of an interception scheme.

THE French Minister of Public Works gave evidence a few days ago before the Parliamentary Committee appointed to study the question of making the long-talked-of "Canal of the Two Seas," and said he was of opinion that the expense of such an undertaking would be so enormous as to render the scheme impossible of realisation.

A BILL relating to the mercantile marine has been presented to the United States Congress on similar lines to the Bill introduced last year, with the exception that the provision for bounties should not exceed 9,000,000 dols. per annum, and that foreign-built ships put on the United States register should have only 50 per cent. of the bounty rates provided.

THE annual returns of the shipbuilding trade for the North-east Coast are practically completed. They include the yards at Blyth, the Tyne, Wear, Hartlepool, Tees, and Whitby, and show the largest production ever recorded in the annals of the industry. About forty firms have launched vessels, aggregating 880,000 tons. The Tyne shows 308,000 tons, being 660 tons more than last year.

THE committee of Lloyd's Register have appointed Mr. Harry J. Cornish chief ship surveyor, and have decided that Mr. James T. Milton shall continue to act as chief engineer surveyor. Mr. Cornish has for a considerable time acted as one of the principal assistants to Mr. Benjamin Martell, who lately resigned the office of chief surveyor. Mr. George Stanbury has been appointed chief assistant to Mr. Cornish.

ON Saturday last the 31-knot Japanese torpedo boat destroyer Niji was launched, with steam up, from the yard of Yarrow and Co., Limited, in the presence of a large number of the Japanese naval authorities. On the following Monday, December 18th, a preliminary trial was made, when a speed was obtained of 31·206 knots. This vessel is the sixth destroyer built for the Japanese Government by the Poplar firm.

WE understand that the Robin and Nightingale, shallow-draught twin-screw gunboats, are to be sent out forthwith to South Africa. These are two out of six vessels of a similar class built by Yarrow and Co., Limited, some two years since. Two of them went to Chinese rivers, and two to the Niger Protectorate. The dimensions of these gunboats are 100ft. in length by 20ft. beam. Their draught was 2ft. when carrying a load of 25 tons, and the speed ten miles an hour.

THE representative of a large Paris firm, says the New York correspondent of the *Morning Post*, has arrived there after a trip through the United States, during which he inspected the goods of the leading makers of agricultural machinery. He has now given orders for 10,000 tons of such machinery and implements, and they are to be shipped to France in the early months of next year. This is only one of the many large orders which have come to the United States for machinery for abroad.

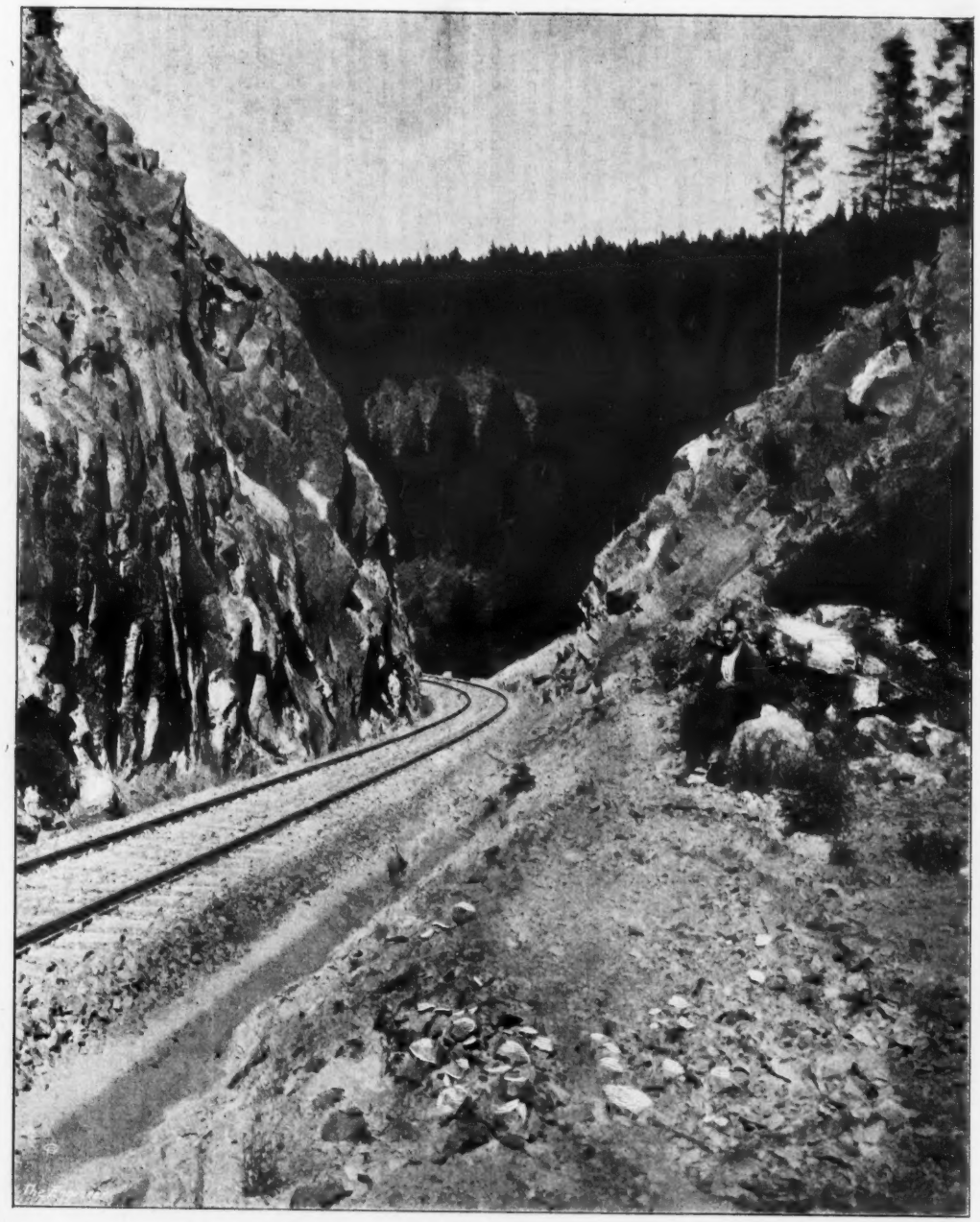
IT was announced last week that the directors of the Union Steamship Company and of the Castle Mail Packets Company have agreed to the terms of an arrangement to be submitted to their respective shareholders for the union of their interests by amalgamation, with a view to more economical and efficient working and to the carrying out in the most efficient manner of their joint mail contract with the Cape Government for the conveyance of the South African mails. The agreement for amalgamation will be submitted to the shareholders in January.

DISSATISFACTION having been expressed by some members of the Scarborough Town Council at the progress made in the work of constructing a marine drive round the foot of the Castle Hill, the Council engaged Mr. C. A. Brereton, to inspect the works and the plans, and to suggest any steps which would expedite the work. When completed the drive will connect the North and South Bay promenades. In his report, Mr. Brereton says the work might be carried through much more expeditiously if the line of the wall were brought in, but he does not make any suggestion as to how far this should be done, nor does he suggest that anything has been left undone which might have been done in the past to carry on the work more rapidly.

THE Manchester Ship Canal Company has deposited the plans in connection with the Bill in Parliament for acquiring the Manchester racecourse. There are three proposals. One relates to the construction of a large dock on the site of the present racecourse. This is to be one of the three docks which it is proposed to make, and will practically run parallel with the existing Nos. 6, 7, 8 docks in Salford. As it is expected that the purchase of the land and the construction of one dock will absorb the whole of the money which may be received from the Mersey Docks and Harbour Board for the Duke's Dock, Liverpool, the company intends to proceed with the construction of the centre dock only until further capital is available. The second proposal relates to the construction of a new railway which will connect the existing lines of dock railway at the east of No. 8 dock, and at a point near the Salford Cemetery. The third proposal relates to the purchase of the land.

MARIENBAD-CARLSBAD RAILWAY

(*For description see page* 628)



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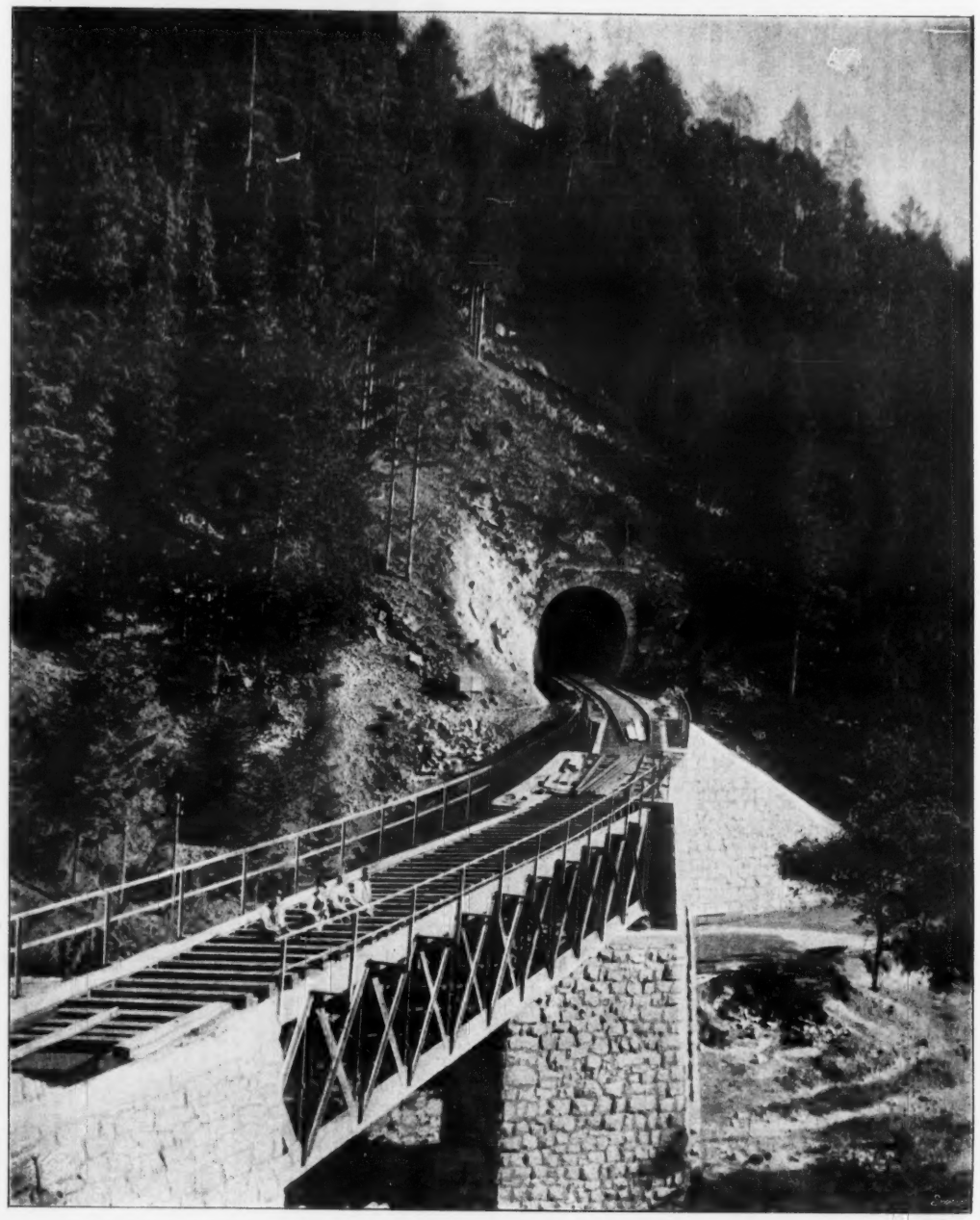

THE MOUTH OF THE TISSAU TUNNEL

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. H. (Widnes).—As no one in this country who has not been on the spot understands what the nature of the Sudd problem is, it seems mere waste of time to make suggestions as to its removal. That is a task which may be safely left, we think, to the able engineers on the spot.

E. G. L. (Bristol).—The title of Mr. Woodroofe Fletcher's article is "The Economic Results of the Ship Canal on Manchester and the Surrounding District." It is published by Chas. Sever, 40, King-street West, Manchester, from whom, no doubt, you will be able to obtain the copy you require.

W. H B. W.—(1) We published sectional drawings of the Lancashire and Yorkshire ten-wheeled express engine on the 17th March, 1899. (2) Write to Mr. Joy, 85, Gracechurch street. (3) There is no special treatise on the proportions of steam engines. How is it possible there could be such a book when the diversity of practice is so great?

C. W. D. (Demerara).—You will find much useful information in Mr. A. T. Walmisley's paper upon "Groynes," which is printed in the Association of Municipal Engineers' "Transactions" for 1897, read at the visit to Dover by that body, where Mr Walmisley is the harbour engineer. There was also a special article on "Groynes" in our issue dated August 6th, 1886, and again with special reference to the Brighton beach in our issue dated August 3rd, 1894, and August 28th, 1896.

S. H. (Dewsbury).—There is no reason why your spring should not supply the village and also feed the reservoir through the same main. Care will have to be taken that the village marked D in your plan does not waste water to such an extent that there will be none left for the reservoir. On the other hand it seems that if the spring is powerful, the reservoir may be filled to overflowing; but we presume there is a proper waste weir provided. The pressure in the village B will be that due to the head at F, and will be very heavy.

INQUIRIES.

JUCKES' GRATES.

SIR,—Will some of your readers put us in communication with makers of Juckes' grates?

London, December 19th. P.

TOOLS FOR MAKING MATHEMATICAL INSTRUMENTS.

SIR,—I shall be obliged to any reader who will give me the names of firms making dividing engines, tools for the production of boxwood scales, curves, set squares, &c.

Davos-Dorf, December 11th. A. N.

DEATH.

On the 19th inst., at The Elms, Putney Hill, S.W., HORATIO BROTHERS, M. Inst. C.E., F.C.S., the last surviving child of Francis Brothers, R.N., aged seventy-seven years.

THE ENGINEER.

DECEMBER 22, 1899.

COMMODORE MELVILLE ON WATER-TUBE BOILERS.

WE read with interest what so eminent an authority as the Engineer-in-Chief of the United States Navy has to say about any department of marine engineering. At the present moment his utterances concerning water-tube boilers are especially worthy of attention. Although it may perhaps be admitted that the water-tube boiler must be used in navies, it has not yet been quite settled what type shall enjoy most favour. A dozen matters are yet in dispute. Commodore Melville read a paper before the American Society of Naval Architects and Marine Engineers last November, in which he set forth the reasons that have led to the adoption of the water-tube boiler in United States warships, and stating the conditions which a boiler of the kind should supply. It is a very honest, outspoken document. There are no technical details worth mentioning. The whole gist of the paper is a setting forth of the special conditions which render it necessary that water-tube boilers instead of cylindrical boilers should be put into warships.

The Engineer-in-Chief of the United States navy does not like water-tube boilers. His condemnation of them is sufficiently sweeping to please the most energetic opponents in this country. "In the first place," he says, "I want to state that water tube boilers are bad in principle. They carry the pressure inside their weakest parts—the tubes. A failure in a tube is followed by the opening of a fault, sometimes to a dangerous degree. In a fire-tubular boiler, on the contrary, the pressure would continue to close a split tube. It is true that a failure of a boiler tube generally comes from pitting, where fire-tubular boilers generally have no such great advantage, as in case of split tubes. Yet failure of tubes is the most common defect in all boilers, and a proper design would place the pressure on the outside of the tube. Water-tube boilers are, from their very definition, designed on a wrong principle, not only because of the direction of application of pressure upon the tubes, but also on account of the decreased amount of water in the boiler, of the increased difficulty of observing a leak, and of the decreased value of heating surface in water-tube boilers. For this reason, as an engineer, it is with some misgiving that I state that I consider water-tube boilers tactical necessities for warships." In these words, "tactical necessities," we have the key to the whole position. The dimensions of a man-of-war are after all limited. If we have two men-of-war in all fighting respects the same, while one has fire-tube and the other water-tube boilers, the latter ship can either carry more coal than the former, or she will be a little smaller and less costly. The question which boiler is to be used is not to be decided on the merits or demerits of the boiler taken alone. We have to do not with boilers only, but with boilers and a ship. Commodore Melville puts this very clearly indeed: "The principal thing to which I desire to call your attention is the fact that all vessels are essentially compromises. Any ship must be considered in its entirety, and the advisability of a change in design of any part must be determined from its effect upon the ship as a whole. Whether or not water-tube boilers are superior to cylindrical boilers as boilers simply, if there be a beneficial effect upon the ship as a whole due to the adoption of water-tube boilers, these boilers are essential to the best design." We do not fancy that any of our readers will dispute the soundness of this dictum.

We learn from Commodore Melville that the Babcock and Wilcox type of boiler is that which has hitherto found most favour with the engineers of the United States navy. They have been fitted to the Marietta, the Annapolis, and the Chicago; and it is reported that they have worked exceedingly well and given no trouble whatever. These are the only modern United States ships of any size in which water-tube boilers have been used. Three old Monitors were fitted with Babcock and Wilcox boilers, about the time of the Spanish war, but these were only land boilers hastily put in to take the place of old boilers quite worn out. They scarcely count. There are being built and repaired several other ships of that navy to be fitted with partial or complete outfits of water-tube boilers. These include the Alert, Atlanta, Cincinnati, Wyoming (Babcock and Wilcox), Maine and Connecticut (Niclausse), Missouri, Wisconsin, and Arkansas (Thornycroft), and Florida (modified Normand). It is worth notice that Commodore Melville never so much as mentions the Belleville boiler.

There are certain points on which he, we are glad to see, insists. One of these is the provision of ample grate surface. We have uniformly urged the importance of this, and we have said more than once that a paramount advantages of the water-tube over the fire-tube boiler, is that with the former a grate area can be secured which is out of the question with the latter. It is interesting to note that no trouble has been experienced with salt water or grease, and we believe that this desirable end has been attained simply because of the care taken to provide adequate auxiliary machinery. We have nothing but praise for Commodore Melville's warning against using feed pumps too small for their work. They answer very well until the boilers are forced, and then they either break down or will not supply as much water as the boilers will evaporate. "I do not think," he says, "that a properly designed water-tube boiler will give more trouble from the use of impure feed-water, such as sometimes we must have at sea, than any other boiler. I do not think tubes more liable than furnaces to fail from a deposit of scale. In any event, the evaporating plants of all our ships are being made adequate to give fresh feed-water. The only danger of salt water in the future should come from leaky condensers." He attributes great importance to the power of getting steam rapidly conferred by the water-tube boiler; but no one disputes this now, and it would be waste of time and space to re-argue a matter quite settled. He has nothing to say in praise of the water-tube boiler for merchant vessels and yachts. It is because he does not like the water-tube boiler, and because his eyes are wide open to its defects, that his pronouncement in its favour possesses value. It is bad in principle, but it is the best thing at present available for a warship. This view saves much trouble. It narrows the field of discussion. It is no longer necessary to try and persuade the Engineer-in-Chief of the United States Navy that the water-tube boiler is a bad boiler. He tells us plainly enough that he knows it is, but he does not know of anything better for the navy. As to the type he has an open mind. His own words, more forcible than elegant, concerning choice of boilers are worth quoting:—"As to the type of boiler to be used there are as many to choose from as there are fleas on a dog. Some one has said that a certain amount of fleas keep a dog from brooding over being a dog. So the number of varieties we have to choose from may be a good thing for all."

The paper concludes with Commodore Melville's statement of his opinions concerning the construction and design of naval boilers. This statement is so valuable that we make no apology for reproducing it here at length. It is tantamount to a direct condemnation of the Belleville boiler on several issues:—"I have always opposed," he says, "the use of boilers containing screw joints in contact with the fire, and have attempted to secure boilers having no cast metal in the pressure parts. Cast steel is not yet good enough to put between 300 lb. of steam and our firemen. I believe in straight tube boilers as being easier of examination and repair than bent tube boilers. I believe in large tube boilers for the same reason, and because the tubes are thicker and have more margin for corrosion. I believe in boilers having as few joints as possible. Water-tube boilers must have freedom of expansion of the various parts, and the simpler the boiler the better. It should not be necessary to introduce reducing valves between the boilers and the engines to secure a steady steam pressure at the latter, nor should it be necessary to have automatic feed arrangements to ensure steady water level in the boilers. To be successful a boiler must be easy of repair. Lightness is a natural attribute of all water-tube boilers, but it is not wise to go too far in this direction. The ratio of grate surface to fire surface occupied for the complete boiler plant must be as large as possible. The units should be large, the grates short and not too wide. The passage of gases through the tubes should be sufficiently long to ensure economy. These gases should be well mixed before entering the spaces between the tubes, for the same reason, and to prevent smoke. The circulation of the water in the boiler must be free. Tubes should not be too long, and the fire-rooms must always be sufficiently wide to provide for free withdrawal."

One point remains to be noticed. Commodore Melville at the outset uses these remarkable words:—"Some day, probably not in my time, we may hope to have a boiler having fire tubes and having the advantages of water-tube boilers. Such a boiler would force its way at

once into all navies, just as water-tube boilers are doing at the present day." It is possible that the day is not so far off as the speaker suggested. It would be premature to say much, but experiments have been carried out recently, under our own eyes, with a fire-tube boiler, with the result that it very readily produced its own weight of dry steam per hour; that it made nearly 8 lb. of steam per pound of coal burned, and that every portion of the boiler is accessible for repair, almost without removing a nut.

THE WORKING OF ELECTRIC LIGHT STATIONS.

SINCE we wrote last week about the Metropolitan Electric Supply Company and consumers, further correspondence has appeared in the *Times*. One consumer had complained that he was deprived of light in order that shops might get it. An indignant shopkeeper writes to say that he and many others in the same district have been left without light just at the time when it is most essential that they should have it; and a somewhat eminent authority, in the same issue, finds an excuse for the Metropolitan Company in the fact that it is no way exceptional in its dealings with the public, other companies having also broken down, and some of the worst failures having taken place under the management of local authorities in the provinces. It is, indeed, a matter of common knowledge that failures constantly take place everywhere, the lights being out for periods varying from one to ten minutes. The consumers have generally been forgiving, and little has been said in public on the subject. We may add, moreover, that it is quite an ordinary matter for the voltage of a circuit to fall; and although the lamps are not out, the filaments are little more than red-hot. We said last week that the supply of steam at electric light stations was a matter that must receive more attention than it has yet got. But it is evident that not boilers alone, but the whole mechanism of supply claims serious attention. It has even been suggested that a Parliamentary Commission should be appointed to inquire into the prevailing arrangements for the supply of electricity in the metropolis, and the methods of working adopted. Unhappily, Parliament will have more pressing matters to deal with, and such an inquiry as we name will have to be postponed to a more convenient season.

For the benefit of such of our readers as are not familiar with the work of a great supply station, we propose to sketch here what goes on every day and night at one. The methods and practice are the same for all with a few insignificant modifications. In the station are boilers, engines, dynamos, and auxiliary machinery, such as feed pumps, well pumps, condensers, coal conveyors, cranes, and so on, to say nothing of switchboards, fuses, and transformers. Every one of these things by breaking down may cause a loss of current. The machinery for supplying current is always subdivided into "units," the size and power of the unit varying, as a rule, between about 300 indicated horse-power and 2000 indicated horse-power. All day long current has to be supplied, for the electric light is fitted in cellars, and in offices in the City which are little better than cellars. The demand during the day is an extremely variable quantity. It depends mainly on whether the day is dark or light. Should the sky become overcast the demand may be doubled or trebled in a few minutes. It will fall off as suddenly as the clouds disperse. Generally one or two small engines are kept running to do the work of the day. As the evening draws on, first one then another of the larger engines is started; and as the demand for current rises, so *pari passu* does the number of engines increase, or the quantity of current sent out by each. As the alternating current, according to such authorities as Thompson, promises soon to be the favourite form of current employed, we may confine our attention to what goes on in stations generating it. When one engine has got its full load and another engine has to be started, a very delicate operation has to be carried out. The first engine is sending pulsating currents with a frequency of, say, 60 per second, and a pressure of 5000 volts along a main. The second engine with its dynamos will have to do precisely the same thing, the current being transmitted along the same main. In order that this may be done, the second engine must be brought into step with the first. That is to say, it must run at such a velocity that the dynamo will give a pressure of 5000 volts, and its phases or impulses must not only occur sixty times in a second, but they must be in perfect time with the first engine. This is termed getting units into parallel. Our electrical readers know how this is done, and what it all means. An explanation which would explain anything to non-electrical readers would be out of place here. The actual way in which the second engine is brought into parallel with the first varies. In some places on the Continent, and also in the United States, the second engine is run faster than the first while without a load, and its speed is gradually reduced until its dynamo is in step with that of the first engine. The slowing down of the engine is effected by the brake action of a large electro-magnet close to the rim of the fly-wheel, which sets up Foucault currents in the wheel; the act of closing the main switch throws the current out of the brake magnet. In this country the second engine starts slowly and is gradually run up to the proper speed. Pilot lamps are mounted on a circuit controlled by a very ingenious apparatus working by induction and known as a synchroniser. The pilot lamps grow bright and die out in regular pulsation. As the speed of the second engine gets nearer and nearer to that of the first, the rise and fall of the light in the pilot becomes less and less marked. The switchman stands by with the lever in his hand watching the pilots. The engineer stands at the throttle valve waiting for the switchman's whistle. At last the two dynamos synchronise. Light in the pilot lamp becomes quite steady. At that instant the switchman turns the current from the second dynamo into the main, and the engineer throws the throttle valve wide open. The second engine has now got its load, and once the two dynamos are in step they will keep there. It is almost impossible to get them out of it, for if one tries to lag the other will pull it forward, and *vice versâ*. Indeed, crank shafts have in this way been broken. Small engines being thrown into parallel with large engines a minute fraction of time too soon or too late, receive a violent jerk, which may break a shaft, the phase being automatically synchronised. Which ever of the two methods we have named is adopted, if the proper instant for using the switch is missed the whole process must be all gone over again. Even if the voltage were the same in both dynamos, unless the phases were the same there would be a conflict between the two, with probably very disastrous effects to both, and certainly no current for consumers. Now, so long as time enough is available, the process of putting two units in parallel is carried out with great skill and certainty. The most that the consumer can notice, if he notices anything at all, is possibly a slight flicker, so to speak, in the light. But whether parallelism is got by working the second engine up to speed or down to speed, it must be understood that several minutes are required to carry out the operation properly—fifteen or twenty minutes is not at all unusual.

In every electric light installation of any importance a stand-by engine is kept turning slowly round all night. It is thoroughly warmed, and can be put to work at a moment's notice. It is there to provide against accident. Let us suppose that No. 1. engine of 1000-horse power has begun with the load, and after a couple of hours No. 2 is put in parallel. All goes well till 9 p.m., and then No. 1 suddenly breaks down. It is switched off at once, and then No. 2 has the whole load, which it cannot carry. All the lights on the circuit either go out or become dim. Then the stand-by No. 3 is put into parallel. But there is no longer time to do this with care. The engine is hunted up to speed as quickly as possible. If the switchman has very steady nerves all goes well; he catches the right moment, and the worst that consumers have to complain of is that their lights were out or very dim for a few minutes. If, however, the switchman loses his nerve the proper instant is missed, and the whole business has to be begun all over again, and the lights may be out for some minutes. The demand for light follows a curve which can be plotted with minutes for a base, and electrical units for vertical ordinates. The curve is more or less regular, but always forming what is known as "the peak," which represents the maximum demand; this occurs at different hours in different districts. Thus, in the West End it takes place when all the shops, clubs, and theatres are open, and gradually falls off as the shops shut. It endures for various periods, from ten minutes or so to an hour. It is often double the normal demand. Most electric light installations have all that they can do to carry on over this bad half hour. Every available engine is not infrequently running, there being for the time no stand-by. The boilers at such times are all doing their best, sometimes goaded by forced draught. The factor of safety becomes a vanishing point. It would take much more space than we can spare to show how this heavy demand tells on the whole economy of a station. One fact will be enough. If all the engines are required, then, should one have broken down over night, it must be repaired in less than twenty-four hours in order that it may take its share the following night. If not, then the other engines are sure to be more or less dangerously overloaded. In the same way, if all the boilers are needed for even half an hour, none can be laid off long enough for proper repairs to be effected. We state an extreme case, but in dark winter weather it is by no means so extreme as might be imagined. Thus, a station has, say, five engines; three take the main part of the load, No. 4 is put on for the peak, No. 5 is a stand-by. But should one of the engines break down badly, or without breaking down require a good overhaul, there is then no stand-by for the peak. Instances are not unknown wherein out of five units only two were available just at peak time, one being laid off for repairs, while, of the other four, one dynamo and one engine had failed.

We have no doubt that it will be said that we have over-stated the case against the companies. That plant is laid down with a margin of power, and that is available. The reply is the experience of consumers. Directors have by degrees absorbed all the original margin in the pursuit of dividends; and, urged by competition, they have put on more and more lamps, without at all making certain that they had plant to supply current. They have not realised that they were going too fast. Engines and dynamos and boilers have been ordered and not delivered, but the work of wiring houses and putting on lamps goes on merrily. The permanent difficulty and danger of electric lighting is that there is no reserve. A gasworks makes gas all day and all night. The gasholders rise during the day and fall at night. They are the equalisers. Electricity can do nothing of the kind. The storage battery on a large scale spells bankruptcy. There can be no certain and steady supply without a superfluity of plant. The peak is always there—it means overwork, and stress, and strain. The companies do their best to keep down the peak. They offer a premium to those who, having a number of lamps, never light them all at once. But such expedients are futile. It is useless to argue that there is twice as much boiler power available as will carry the normal load. If the peak is double that, then every boiler in the place must be at work for that time. How, under such conditions, can boilers be laid off for cleaning and repair? It takes a full week to clean a water-tube boiler using London water. They should be cleaned at least once a month; this means that not more than three-fourths of all the boilers can be available for the peak. How many companies can now say that they can carry their heaviest load with three-fourths of their boilers? The companies will have to make up their minds to accept an unpleasant fact—they must spend more money on plant. They can no more take on thousands of lights without adding to their machinery than could a gas company without putting up more retort houses.

THE PARIS SEWAGE INUNDATIONS.

THE contention of the Paris sanitary engineers that the suburban populations look upon the sewage farms with considerable favour was vigorously refuted in the Chamber of Deputies during the debate upon the budget estimates, when the representatives of the districts which have the doubtful privilege of receiving the Paris sewage objected strongly to the inconveniences to which they were put. Judging from the complaints of deputies, the situation is much more serious than was at first supposed. Not only is the district of Pierrelaye inundated with sewage, but the neighbouring commune of Méry is equally affected. Saint-Ouen-l'Aumône is suffering from the same cause. The whole of the area included in the arm of the Seine from Andrésy to Carrières-sous-Poissy is inundated with sewage, and the old stone quarries which were employed for cultivating mushrooms have been converted into foul lakes to a depth of ten or twelve metres. At Grésillon the fields are covered with sewage, and agriculturists, who were told that their land would bring forth tenfold, now find themselves on the verge of ruin. At Méry it was understood that the quantity of sewage pumped on the land would not exceed 40,000 cubic metres per hectare per year, but considerably more than this amount has been sent there, and agriculturists are complaining that they are getting twice as much sewage as they want. All the numerous quarries which exist throughout this district have become vast underground reservoirs of sewage, and it is urged that the water in the wells which have been contaminated will never again be fit for drinking purposes. A still more serious matter is the possibility of the sewage finding its way into the Oise, and thus poisoning the source of supply for the whole country extending from Pointoise to Saint Denis, and having a population of 100,000 inhabitants. The responsibility for this state of things is, of course, laid on the shoulders of the municipal engineers. They found that the Achères farm gave good results temporarily, and believed that the system would prove equally satisfactory on the plateau which separates the valleys of the Seine and the Oise. But the geological conditions vary so considerably that even a most superficial investigation should have shown the impracticability of a farm at Pierrelaye. Achères is a perfectly level country, with a uniform stratum of what are called Beauchamp sands, varying in depth of from three to eight metres. The district would therefore appear to be as favourable for the laying out of a sewage farm as it would be possible to expect, but even here it does not seem to have been an unqualified success. When this farm was inaugurated, and the collector at Clichy closed with great ceremony, it was announced that henceforth not a single cubic foot of sewage would go into the Seine. The following day, during a storm, the collector had again to be opened to discharge its contents into the river. Since then it has frequently been found necessary to send the sewage into the Seine, with the result that at Asnieres the river is hardly less nauseous than it was before the sewage was diverted to Achères.

What makes the selection of Pierrelaye still more incomprehensible is that it was strongly condemned in the report of Dr. Bourneville, who was one of the chief advocates of the Achères farm. He urged that the permeable Beauchamp sands were particularly suitable for such an installation, since the passage of air and water through the sands oxidised the organic matter. The plateau, on the other hand, is formed chiefly of argillaceous strata, and at Pierrelaye and Méry it is composed of calcareous deposits, which, on becoming dry, have cracked and split in all directions. The land is certainly permeable, but in passing through these fissures the organic matter has no time to oxidise, and the land either becomes water-logged or the sewage flows off into neighbouring districts. This theory would seem to be supported by the character of the water which flows from the sewage farm into the Oise. The municipal engineers point to analysis, and say that the water is perfectly pure, but the local population protest that it is nothing of the sort, and pin their faith on the sagacity of animals which refuse to drink it. It appears that the engineers were induced to adopt the site at Pierrelaye on the ground that a permeable alluvial soil a metre in thickness was quite sufficient to filter and oxidise thoroughly the quantity of sewage they proposed to divert on the land. It is now urged that the Beauchamp sands overlying the calcareous beds do not in any case exceed a metre in thickness, and are for the most part considerably thinner. This would have been proved had the engineers taken the ordinary precaution to make borings, but, singularly enough, nothing was done to ascertain the exact nature of the strata before carrying out such a vast and costly installation. The Municipal Council, of course, still protests that the farm has been established on perfectly satisfactory lines, and that the present inconveniences may be classed among those accidents which invariably take place in undertakings of this kind. The apologist of the Council in the Chamber of Deputies states that the drawbacks can be easily overcome by a system of drainage. If the drainage has not been carried out before, it is because the engineers have had to wait and see under what conditions it could be properly carried out. In other words, they have created a disease which they are obliged to study before they can find a remedy, and it is feared that the disease has gone too far to be attenuated in any way except by a total suppression of the farm. A Commission has been appointed thoroughly to investigate the matter, and when its report is presented it is to be the subject of a lengthy debate in the Chamber of Deputies. Despite the energy with which the principle of the sewage farm is being supported by the sanitary authorities, there is no

doubt that these failures to give it practical effect have done much to turn public opinion against this application of the *tout-à-l'egout* system.

A FAMINE IN FUEL.

THERE was a threat the other day of a coal famine in the Welsh coalfield. This was attributed not on account of any scarcity in coal or dispute in the industry, but solely to the inability of the railway companies to convey it from the collieries to the consumers. The fear, exciting as it was, did not concern a solitary coalfield of the kingdom. In the Sheffield and South Yorkshire districts the congestion of traffic on the railways has been so serious as to gravely interfere with the manufacturing processes carried on in the city. In one of the largest of the east end great works devoted to the production of military material, blast furnaces have had to be stopped, and part of the establishment thrown idle through sheer want of fuel. The principals state that they have hundreds of wagons somewhere on the lines which contain the fuel they are so seriously in need of. In another of these huge establishments there had not been a single truck of coal delivered last Tuesday up to five o'clock in the afternoon, and one of the directors stated that this would cause them to begin their holidays earlier this year, although they are so pressed with work that they could scarcely afford to give any holidays at all. Although the congestion may be more keenly felt in the Sheffield district than in other parts, it is quite evident that it is not peculiar to the Yorkshire coalfield or to the Welsh. The truth seems to be that through insufficient engine power and rolling stock, as well as from the prevalence of fogs, traffic upon the English railways has been of late very much impeded. There is a graver reason even than this. It is clear that the carrying trade of the country has advanced by such enormous strides that there are not sufficient railway lines to permit of its being effectually handled. It would be necessary, to find the cure for the complaint, to double the lines in all directions—a work which, of course, would cost both time and money. Railway managers say that they could scarcely be expected to anticipate the astounding expansion of trade which has taken place of late months, and it has to be remembered, so far as engine power is concerned, that we are still suffering from the evil caused by the engineering strike, which closed the home establishments and caused the companies to place orders wherever they could get their work done. Several of the railway companies are helping each other, and every effort is being made to tide over the time of trial, but it is undoubtedly the case that the engine power, as well as the wagon stocks, are altogether unequal to the strain upon them. The drivers, firemen, and others are stated to be doing their utmost to loyally help their employers, and there never was a time of so much anxiety to the responsible heads, as well as to those who have to carry out their orders.

THE INSTITUTION OF CIVIL ENGINEERS.

THE discussion on Tuesday evening last, at the Institution of Civil Engineers, of Mr. C. Newton Russell's paper on "Combined Refuse Destructors and Power Plants" may be characterised as having been dreary. The subject itself is full of interest, and this being so one might have expected the speakers to be interesting also. We are bound to say, however, that generally speaking the discussion did not add greatly to the common knowledge of the subject. There were some speakers who may possibly have been giving to the meeting some most entertaining details. If this were so we can only regret that their voices were, as nearly as possible inaudible to the majority of the listeners. Their speeches will doubtless appear later on in the "Proceedings" of the Institution—if the reporters managed to take them down—but for the moment many of those present must be in ignorance of what was said. This was not, however, the case with everyone. There were some notable exceptions, and we can only regret that we must obey the laws of the Institution, and refrain from quoting much that was said. We particularly regret this in the case of one gentleman, who talked with an experience of over twenty years, and mentioned the first and second destructors ever built—at Manchester and Leeds—some twenty-two or twenty-three years ago. In the case of the first of these the heat produced was used for concentrating liquor, and in the other for raising steam for driving an engine to work a mill for grinding up the clinker produced in the destructor. Refuse then was much lower in calorific value than it is now. Why, some refuse now-a-days must have a calorific value of 6500 British thermal units to go anywhere near the efficiency attributed to it in some tests! An apt illustration was given by one speaker. "If," he said, "when you go home you find a fire burning in the grate composed of, say, six separate pieces of coal, and if you take these one by one and deposit them in different parts of the hearth, you will soon find that they have all gone out." In much the same way it is with refuse. Each portion of combustible refuse has round it four incombustible portions which make it all the harder to burn the combustible portions. The last speaker gave an ingenious method of stopping water hammering in feed pipes, and showed graphically, by means of projections from a lantern, the different effects of putting hot and cold feed-water into a boiler. The meeting was prolonged till nearly 9.40, so as to complete the discussion. The author could not reply because there was no time. He will do so in writing. The Institution has now adjourned till after Christmas, and the next meeting will be on Tuesday, January 9th.

THE PROJECTED FRENCH CABLE.

IT has been an open secret for some time that France is resolved to bring about cable communication with Madagascar and Indo-China by means of a submarine cable, which shall not only avoid the Suez Canal, but shall also be free from British control. Details have just been made known at Marseilles concerning the project for laying a French cable thence across the Mediterranean Sea and through the Red Sea. Turkey has consented, in return for certain unspecified concessions, to allow the French cable to be laid on Turkish territory from Jaffa to Akabah, on the north-eastern horn of the Red Sea, a distance of 350 kilometres. Akabah is a Turkish haven on the peninsula of Sinai. From Akabah the cable will pass through the Gulf of Akabah into the Red Sea, and will thus escape the sphere of British influence. On leaving the Red Sea, the cable will have two directions—one being to Indo-China, and the other to Djiboutil, on the African coast of the Red Sea, and thence to Madagascar. It remains to be seen what steps will be taken by the promoters of this cable to secure an exit for it from the southern opening of the Red Sea through the Straits of Bab-el-Mandeb, which, from a French point of view, are virtually in the hands of Great Britain.

WIRE AND CABLES FOR THE NEW YORK SUSPENSION BRIDGE.

THE great suspension bridge of 1600ft. span, which is now being built across the East River at New York, a short distance above the Brooklyn suspension bridge, is fast approaching completion, and the specifications for the cable wires have been prepared by the chief engineer, Mr. L. L. Buck. The cables will be four in number, extending from anchorage to anchorage, 2834ft. horizontal distance, and passing over saddles on the steel towers, 256ft. above the point of attachment of the cables to the anchors. The two cables on each side of the bridge will be close together at the centre of the span, 160ft. above the water, and then gradually spread apart until the two inner cables are close together at the anchorage. Each cable will be made of thirty seven strands, each containing 281 wires of No. 8 gauge, laid straight, and spliced with sleeves having right and left threads, as used on the Brooklyn Bridge. When all the wires of a strand have been laid, and before the shoe is placed in its final position on the pin, the strand will be held together by temporary bands of wire until all the strands of the cable have been completed. These bands will then be removed, and the whole 10,397 wires will be firmly clamped into a cylindrical cable by the main bands of cast steel which carry the suspenders for the support of the floor beams. In the intervals between the bands there will be wire bands or wrapping. When all these permanent bands are in place, the cables will be covered with steel plates, overlapping so as to shed water.

The temporary bands for the strands will be composed of five or six turns of No. 10 steel wire, securely locked, and will be at intervals of not less than 5ft. For the ends of the strands within the anchorages the bands will be permanent, and not more than 2ft. apart. The cast steel bands for the suspenders will be 20ft. apart horizontally, and the intermediate bands between them will be about 4ft. apart, and composed of eight turns of No. 8 wire, securely locked. The steel covering will be of cylindrical form, of $\frac{1}{16}$in. plates.

Each cable strand will be built several feet higher, or with a smaller versed sine than its final position in the cable. This will be accomplished by placing the shoe at one end of the strand several feet back from its final position. When the strand is finished the shoe will be placed on the permanent pin, and the strand will be adjusted to its proper versed sine. During erection the saddles will be placed about 6$\frac{3}{4}$in. back of their mean position on the saddle beds; and the cables between the main towers and the anchorages must be supported at the elevations which they will assume at mean temperature when the total dead load of the bridge is suspended from their main spans. The lower portions of each cable will be supported in their proper permanent positions at points near the cable clamps within the anchorage. As each of the strands of the upper portions of the cables is lowered into permanent position, it must be pressed down and held to its place at these points in adjusting to position. The suspenders, with their sheaves and fittings, will be put in place on the grooved cable bands when the cables have been completed. There will be no suspenders between the towers and the anchorages, and no diagonal stays will run from the towers to the stiffening trusses of the bridge.

All steel for wire must be made in an open-hearth furnace lined with silica, and must be made entirely from pig iron, without the admixture of scrap of any kind or form, and without the use of any other stock. No portion of the pig iron shall contain more than 0·06 of 1 per cent. of phosphorus nor more than 0·05 of 1 per cent. of sulphur. The use of iron ore for the reduction of carbon in the furnace charge will be allowed according to usual and good practice. The recarbonisation of steel and the addition of manganese shall be accomplished by the use of ferro-manganese or spiegeleisen only, and shall be performed carefully in a manner most likely to give good results. During the reduction of the steel in the open-hearth furnace, it shall not be decarbonised below 0·10 of 1 per cent. The finished steel shall not contain to exceed the following limits of the elements named:—

Phosphorus	·04 of 1 per cent.
Sulphur	·03 " "
Manganese	·50 " "
Silica	·20 " "
Copper	·02 " "

The finished steel shall be made into bottom cast ingots, not larger than 16in. square in greatest cross section, weighing not more than 5000 lb. each, and cast in groups of not less than six ingots to each group. The steel shall be run slowly and continuously from the ladle, in order that the ingot moulds may fill gradually with the steel at as low a temperature as practicable. All portions of ingots containing bubbles shall be cut out. Sand shall not be thrown in the top of the ingot moulds after they have been filled with steel. The engineer reserves the right to take drillings from the finished steel for check analysis, and the same must not show an increase over the specified limits for phosphorus or sulphur of more than 25 per cent.

Steel for castings shall also be made in an open-hearth furnace lined with silica. At least one-third of all stock shall be pig iron, and where scrap is used it shall be of a kind and quality satisfactory to the engineer. During the reduction of the steel in the furnace it shall not be decarbonised below 0·10 of one per cent. The use of iron ore, ferro-silicon, ferro-manganese, and spiegeleisen, will be allowed according to usual and good practice. The finished steel shall not contain more than the following limits of the elements named:—

Phosphorus	·06 of 1 per cent.
Sulphur	·04 " "
Manganese	·80 " "
Silicon	·35 " "

All steel castings shall be carefully and thoroughly annealed. Test pieces taken from coupons on the annealed castings shall show an ultimate strength of not less than 60,000 lb. per square inch, an elongation of not less then 20 per cent. in 2in., and shall bend 90 degrees around three times their thickness without rupture. All steel castings must be true to the drawings, with smooth surfaces, and all re-entrant angles must be neatly filleted. The main bands and suspender sheaves must have the grooves—in which the suspenders are to rest—chipped and filed to remove all irregularities, and to leave them smooth and true.

The methods of manufacture, and the chemical requirements of the steel for all bolts, bolt ends, nuts, and cover plates, will be the same as those of the steel for wire. It must have the following physical requirements:—

Maximum ultimate strength	68,000 lb. per square inch.
Minimum " "	60,000 lb. " "
Maximum elastic limit	35,000 lb. " "
Minimum percentage of elongation	20 per cent. in 8in.

All bolts will be turned and machined, and all screw threads shall be of the United States standard.

All stock and materials used in the manufacture of the steel, and all the operations at the furnaces, rolls, or elsewhere, shall be subject to the examination and approval of the engineer and his inspectors, who shall have free access to all records appertaining to the manufacture of the steel from the beginning until its final acceptance, and shall be furnished with copies thereof.

All superintendents, firemen, melters, helpers, and others engaged in the manufacture of the steel, shall be men experienced in this line of work, and of sufficiently recent practice to ensure the best results. The manufacturer shall have an analysis of every melt made by a chemist satisfactory to the engineer, and two copies thereof shall be furnished to the inspector appointed by the engineer. All specimens for testing must be made to shape required by the inspectors. The inspection will be very thorough, and tests will be made and repeated as often as is deemed necessary by the engineer, to satisfy him that none but the best material goes into the work. A piece of wire 10ft. long shall be cut from each coil of wire by the inspector at the site of the bridge, and no coil shall be used until the tests therefor have been fully completed. When said open-hearth steel is made in mills producing other kinds of steel, no material will be accepted unless made especially for this work, and when so made it shall be subject to a system and manner of identification approved by the engineer. Furthermore, such especially made steel shall be handled and manipulated by itself, or isolated in any manner required by the engineer, to prevent the possibility of its becoming mixed with other kinds of steel. No steel shall be made or cast unless the engineer or his representative is present.

The wire for the cables, suspenders, and ties must have an ultimate strength of 200,000 lb., or nearly 89 English tons or more to the square inch, and must have an elongation under test of at least 2$\frac{1}{2}$ per cent. in 5ft. of observed length, and 5 per cent. in 8in. of observed length. It must be capable of being coiled cold around a rod of its own diameter without cracking. All wire will be bright, and for the cables it will be of size No. 8, Birmingham wire gauge, not straightened by machine, but drawn absolutely straight and free from any tendency to coil when unrolled from the drums. It shall be made in lengths of not less than 4000ft., and shipped to the site on drums of such diameter as not to cause any tendency to coil.

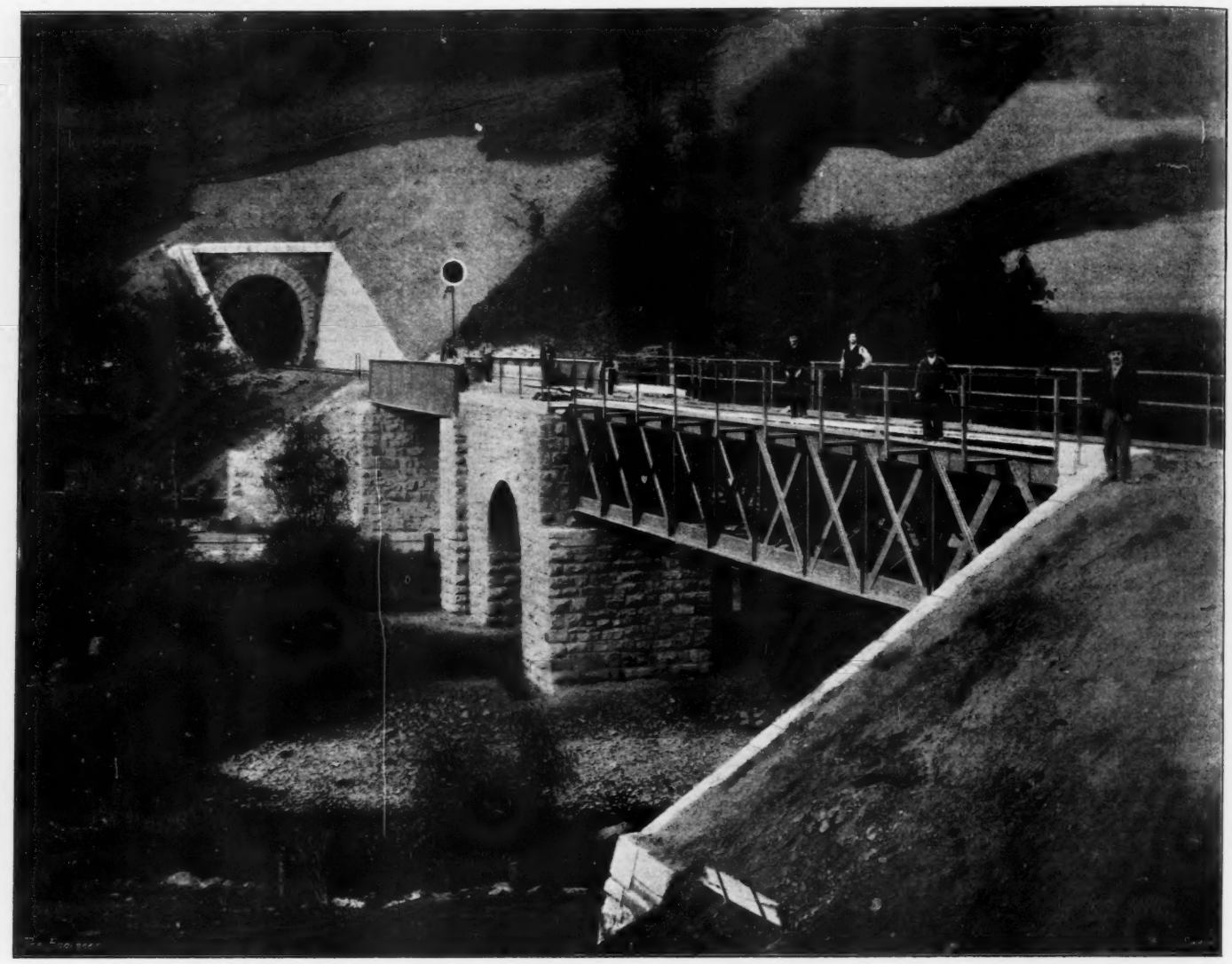
All the wires of each cable strand will be spliced so as to form one continuous wire. The splices must be made so as to have a strength of at least 95 per cent. of the strength of the wire. The splice which will accomplish this result with the least increase in size above that of the wire will be approved by the engineer. The right and left sleeve nut splice, used for the cables of the New York and Brooklyn bridge, is the only one known to the engineer which will give the required strength. The lengths of the wires must be so arranged that the splices will be uniformly distributed throughout the cables.

The suspenders will be made of seven-strand—wire core—steel wire rope, 1$\frac{3}{4}$in. in diameter. The two ends of each suspender will have socketed screw ends, one with a right-hand and the other with a left-hand thread. These screw ends will be joined by a sleeve nut. The suspenders and ties must be laid or cut off under a stress of not less than 10 per cent. nor more than 15 per cent. of their ultimate tensile strength. The suspenders will be made of such lengths as to permit the adjustment provided for.

As soon as the wires are made they will be coated by immersion in boiling linseed oil. Each of the cable strands will, while it is being banded with the temporary bands, be filled with as much "cable shield" composition as it will hold. Before the main cable bands are put on, the interstices of the cables will also be thoroughly filled with similar composition, and after the bands are in place the outside of the cable will be coated with the "cable shield" composition. During their manufacture the suspenders will be filled with as much "cable shield" as they will hold. Before leaving the shops the main bands and the steel cover plates will receive two coats of durable metal coating, inside and outside. After the suspenders are in place and the erection of the suspended structure has begun, the suspenders will receive two coats of durable metal coating. When the cables and suspenders are fully completed the main bands, cover plates, suspenders, and all connections, will receive two coats of approved white paint.

AMERICAN TRADE IN SOUTH AFRICA.—The partial suspension of business activity in South Africa, due to the war, has served to call attention to the rapid growth of American commerce in that part of the world during the past few years, and the popularity of American products and manufactures when brought into competition with those of nations which had been formerly supplying those markets. A recent number of the *British and South African Export Gazette* contains a series of statements on this subject, and quotes Mr. J. Solomon, a Capetown merchant, as saying: "In some respects the British manufacturer is outdoing his American competitor, but I am afraid that in many cases the latter is getting the decided advantage. The former cannot afford to lose this important market, which, in my view, he does not study sufficiently. On the other hand, the American manufacturer goes out of his way to please his clients in order to grasp a probable order. Take boots and shoes, for instance; it used to be asserted that American boots would not fit English feet, but American manufacturers now use English lasts. It is the willingness of the Americans to adapt themselves to required styles which has principally gained for them so large a share of the South African trade. Quite a number of Capetown houses now handle American goods. As regards Germany, England cannot touch it in the matter of blankets and chinaware, and in these and some few other classes of goods they are making important inroads into the market." Mr. Robert M. Eadon, a Sheffield manufacturer, is also quoted as saying that "American manufactures are rapidly gaining in favour. Several lines were mentioned in which the superior finish of American or German goods has caused their more extended adoption at our expense. American engines, Mr. Eadon found, were much in evidence in South Africa, especially in the interior. Their lighter weight, and the consequent smaller transport charges, where they have to be conveyed inland, frequently without the aid of railways or steamers, has, he said, no small part in effecting their readier acceptance. American mining machinery, saws, and axes, were met in much greater quantity than the same class of goods from British workshops, but, apart from these goods, the latter had not lost to any noticeable extent.

MARIENBAD-CARLSBAD RAILWAY—VIADUCT AT PETSCHAN



THE NEW MARIENBAD-CARLSBAD RAILWAY.

We give on page 224 some views of the interesting new railway between the celebrated Bohemian "Spas," Marienbad and Carlsbad. The line is single, with sidings at the stations for the passing of trains. The total length is 53 kilometres, and the work of construction and the cost have been great, as most of the line runs through mountain and rocky country, where important blasting operations have been necessary. There are eight tunnels and thirteen bridges and viaducts, whilst some 2½ million tons of *débris* have had to be removed. The line runs through one of the most picturesque parts of Bohemia, and is much patronised by tourists and "curgästen" of the two watering places.

The line from Marienbad at first follows the Vienna-Eger State Railway, and branching off at the spring Rudolfsquelle, rises straight up the slopes of the Templer Mountain to the villages of Auschowitz and Stanowitz, where at Tissana the longest tunnel—five kilometres—is passed a little before the next station, Wilkowitz, is reached. Here a splendid panorama is unfolded of the town of Michelsberg, perched high up on the mountain, viewed through the wild valley of Buchthal. Hence the line continues upwards, past the village of Valiakladran, to the peak Podhomberg, the highest eminences being situated at an altitude of 3000ft., where a lengthy stoppage is made to enable the travellers to view the fine view of mountain, dale, and forest.

The line then descends to the Stadt Teps Station, and running through the beautiful Tepl valley across several bridges and viaducts, and through a second long tunnel, reaches the Petschan Station. This spot, which is situated halfway between Marienbad and Carlsbad, promises to become a favourite pleasure resort for the visitors to both Spas, and for their comforts a good hotel has been built at the railway station. On the last section to Carlsbad are the stations Schönwehr, Töppeles, and Aicht-Pückenhammer. The line is constructed and worked on the Abt cog-wheel system, and promises to become very profitable.

CHEAP FUELS AND THE COST OF ELECTRICAL ENERGY.

On November 23rd last Mr. R. E. Crompton read an interesting paper before the Institution of Electrical Engineers entitled "Influence of Cheap Fuels on the Cost of Electrical Energy." The question of the extent of the available sources of cheap fuel was first of all gone into. The author did not think that this branch of the subject had received sufficient attention. He had ascertained that in the Midland district there are supplies of slack coals available, the average price of which during the last ten years had been 2s. 6d. at the pit mouth. These could be delivered within a radius of fifty miles at a cost of 5s. 4d. per ton, including wagon hire. At the present moment the price was 3s. 6d., but he was informed that this was only temporary, and he considered that 5s. 4d. was a very fair figure to take as a basis for making calculations. Railway rates are the same, no matter what the price of the coal, so that it does not seem probable that it will pay to deal with cheap fuels at a greater distance than fifty miles from the colliery. Where canal transport is available, however, these conditions will be modified on account of the much lower rate for carriage and barge hire. There are three distinct classes of cheap coal available for generating electrical energy. The first are those in which the calorific value is chiefly in the contained carbon. These include the anthracite and small Welsh coals. They are cheap because they are easily broken, and there is always loss in transit. Such powdered coal is liable to fall through the bars or be carried in the form of dust into flues and chimney. The second class of cheap fuel is the free-burning small coals of the Midland district. In this class are included all the small and earthy coals which are only slightly bituminous, and which, therefore, have slight tendency to cake. The third class consists of the small and dirty or earthy bituminous coals of the North. These are the most difficult to deal with, but they possess a high calorific value, and hence become the most interesting of all.

The coals of the first class have been satisfactorily dealt with in several classes of furnace. Up to the present the attempts to deal with the coals of the second and third class have been chiefly connected with the use of automatic appliances for distributing the fuel over the bars, breaking up and getting rid of the clinker, and providing sufficient admixture of air at various points in the furnace to ensure satisfactory combustion of the gases. The difficulties in this direction are greatest where a portion of the calorific value of the fuel lies in its volatilisable products. Generally speaking, it is not wise to use the very cheapest class of fuel in mechanical stokers. With bituminous coal, coking stokers have been used with more or less success. One great difficulty in burning cheap fuels at a small cost for labour and maintenance is that of getting rid of the clinker. What is really required is that the fuel should be tipped from railway wagons into conveyors, and thence distributed to the furnaces without being touched by the firemen, and that the clinkers and ashes should also be taken automatically away to other railway wagons.

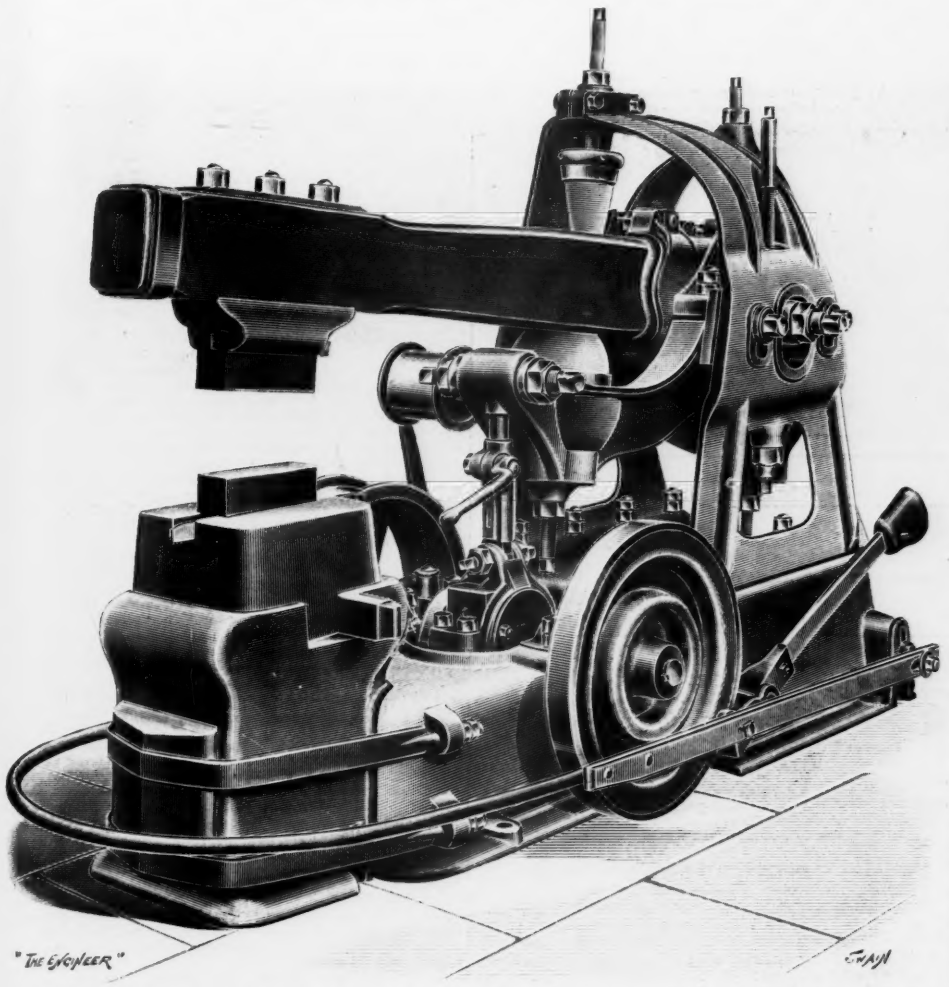
Mr. Crompton then went on to say that probably the simplest and most efficient method as yet contrived of continuously firing a large grate with cheap fuel is by the old Juckes revolving grate, which has now been in use for over thirty years. This Mr. Crompton would now suggest in conjunction with a conveyor for removing the clinkers and ashes, and a combustion chamber of special construction. This chamber, he has found by experiment, may be constructed in the form of an extended fire-brick arch, each arch-shaped brick having a fin-like projection hanging down from its lower surface into the paths of the gases. This formation acts as a reservoir of heat. This regenerative apparatus may be dispensed with in burning the first class of fuels; it is somewhat more necessary in the case of the second group, but is absolutely necessary with the third, *i.e.*, that consisting of bituminous smoky fuel. Up to the present the weak point of smoke-consuming apparatus has been that it has generally stopped short at supplying additional air, so as to obtain more perfect combustion of the fuel; and although this has resulted in the production of a larger proportion of CO_2, yet this has been effected by passing a considerable excess of air through the furnace with a resulting loss in output and efficiency. The only satisfactory method of dealing with the question, says Mr. Crompton, is to provide the combustion chamber he suggests, in conjunction with a revolving grate.

The question of the proportion the cost of fuel bears to the total cost of generating energy in a modern station of moderate size was then dealt with, and some interesting figures were given from the log-book of the power station at Mr. Crompton's Works at Chelmsford, showing the average costs taken over forty-nine weeks. It appears that the average price paid for coal was 17s. 5d. per ton—Nottinghamshire steam hard of the best quality. The cost of the fuel was 64 per cent. of the total cost of 0·77d. per Board of Trade unit delivered to electrically-driven tools. The plant is comparatively small in size, the maximum rate of output, including spares, is about 250 kilowatts. The average output is probably about 150 kilowatts during fifty-four hours per week, and 50 kilowatts during the night shift of sixty-two hours per week. If the plant had been worked at the higher rate throughout the night as well as the day shift, the output would have been increased from 368,000 to 680,000 Board of Trade units. The cost of coal would then have been modified, and would have been about 76 per cent. of the total cost of about 0·63d. per unit. Had the plant been put to work within fifty miles of a colliery where cheap fuel at 5s. 4d. per ton could be supplied, and the furnaces modified as already suggested, then if the output had been 368,000 Board of Trade units the cost of coal would have been 35 per cent. of a total cost of ·431 per unit, and if the output had been 680,000 the total cost would have been only ·300d. of which the cost of coal would be 49 per cent. Mr. Crompton thinks it quite possible that by increasing the size of the plant the total cost of only ½d. per Board of Trade unit would be reached in many cases, providing that the coal obtainable at 5s. 4d. per ton is burnt in a satisfactory manner.

It is expected that the work of constructing the Yorkshire Dales Railway—Skipton to Grassington—will shortly be commenced. The chairman of the company—Sir Matthew W. Wilson—says the directors can see their way to carry out the work for a sum not exceeding the amount of the share and loan capital —£60,000. All the capital except £9300 has been subscribed.

CUSHIONED HAMMER

THE BRADLEY COMPANY, SYRACUSE, U.S.A.



THE IMPROVED BRADLEY HAMMER.

MANY of our readers will be familiar with the original Bradley hammer, an adjunct to the smith's ship, the usefulness of which it would be difficult to over-estimate. With the form illustrated, and its somewhat important improvements, engineers in this country are not quite so well acquainted. The general features of the hammer will be obvious from our engraving. It is operated by a belt which runs round the drum, shown at the further side of the machine, and which is tightened or slackened at will by means of a jockey pulley, also shown, which is moved in or out of contact with the belt by means of the foot-treadle extending all round the front of the machine. The drum referred to is secured to the main driving shaft, which is connected, and imparts a rising and falling motion to the helve by means of an excentric and connecting-rod attached to an oscillator secured to the helve. On the other end of the shaft is a balance wheel; this wheel also provides on its rim surface for the operation of a brake, which comes into action automatically when the foot of the operator is taken off the treadle. In the design of machine illustrated, the helve is made of two parallel pieces of timber, and is cushioned above and below at either side of its fulcrum by means of massive rubber buffers. These tend to absorb the shock or jar, and give spring and life to the blow, making it resemble as nearly as possible that delivered by the human arm. As will be seen, the anvil block is a separate casting, having its own foundation, thereby preventing the danger of breakage of the frame by crystallisation brought about by constant jars. The joint between the block and the bed is made with a packing of wood, and being circular, permits of the block being shifted, if necessary, to bring the dies into alignment, while the bolts hold it secure wherever placed. The length of stroke may be varied to suit the work in hand by means of the excentric alluded to above, which is made easily adjustable. In order to provide adjustment for the hammer-head to suit the different sizes of stock which may be used, the connecting-rod between the excentric and the oscillator is made telescopic by means of an adjustable split sleeve fitted over the rod, and capable of being readily tightened up or slackened by means of the lever shown.

The machine is made in different patterns by the Bradley Company of Syracuse, New York, U.S.A.; and the agents in this country are Buck and Hickman, Whitechapel-road, London.

COAL TRADE RECONCILIATION.

MOST prudently the coalowners of the kingdom are putting forth every effort to avoid anything in the shape of labour troubles next year, and in the period which may be expected to succeed, in which a continuance may be marked of the current trade prosperity. With this end they are willing to go a very long way in meeting the claims of the colliers to any reasonable degree. The example of amity which has been set by the Coal Trade Conciliation Board sitting at Westminster, in its recent decision to continue the Board for a further period of three years from January next, with an immediate advance of 5 per cent. in wages, and an increase in the maximum to 60 per cent. on the 1838 standard, is, we are glad to note, being followed by the other Boards operating in individual districts of the kingdom. Scotland, Durham, Northumberland, Lancashire—in all these coalfields wages difficulties are being overcome or steered clear of. This week the Coal Trade Wages Board in Staffordshire and East Worcestershire have consented to give the men a 5 per cent. rise, so as to bring wages up to the maximum agreed upon by the National Federation for next year, and now news is to hand that a threatened sliding scale crisis has been avoided in South Wales. This last arrangement is more in the nature of a reconciliation among the coalowners themselves than a direct agreement with the men. But its effect is what we have stated. It seems that last midsummer certain collieries, with an aggregate output of 1,500,000 tons a year, were admitted into membership with the rest of the South Wales Coalowners' Association at the close of the late strike, in spite of the fact that they had kept their pits open during the strike. These admissions so incensed other important colliery interests in South Wales, prominent amongst whom were the Marquis of Bute's trustees and the Lewis Merthyr Colliery Company, that these owners served notice to retire from the Association at Christmas. Had the retirements been carried out it is quite within the bounds of probability that the miners would have broken through the sliding scale. This instrument and guarantee of peace has still four years to run. Its repudiation, therefore, in the recent prosperous state of the coal trade would have been a matter for loud regret. Happily all fear of such a calamity has now been removed. The notices handed in by the disaffected coalowners have been withdrawn. In the reconciliation which has been effected the injured coalmasters, if the term may be permitted, have shown sound judgment, and in the best interest of trade we trust that the new friendships may be long unbroken.

COMMITTEE ON COPPER CONDUCTORS.

THE advantages of standardising are being largely advocated for almost all classes of engineering products, but copper conductors have hitherto not been included in the list, as every one has assumed that they were already standardised, and that Matthiessen had settled the resistance and temperature coefficient of copper in his researches nearly forty years ago.

This assumption is far from being true, and the catalogues of various electrical cable makers as published before 1899 show considerable discrepancies in the resistance and weight of nominally the same cables, while the Post-office issued a specification differing from all of the others.

In order to remedy this confusion a Committee was formed of those interested, to determine a standard, and the Institution of Electrical Engineers, the General Post-office, and the principal manufacturers of rubber insulated cables sent representatives. Meetings were held early in 1899, and the report given below was adopted by the following delegates:—Sir W. H. Preece, K.C.B., F.R.S., Chairman; Mr. J. Gavey; Mr. H. Hartnell—for the General Post-office; Professor W. E. Ayrton, F.R.S., Mr. W. M. Mordey, Mr. Herbert A. Taylor, for the Institution of Electrical Engineers; Mr. J. W. Conolly, Conolly Brothers, Limited; Mr. R. J. Hatton, Henley's Telegraph Works, Limited; Mr. W. E. Gray, I. R. G. P. and Telegraph Works, Limited; Mr. A. Paterson, Johnson and Phillips; Mr. F. Jacob, Mr. J. S. Huddlestone, Siemens Brothers, Limited; Mr. A. H. Howard, W. T. Glover and Co., Limited. The Telegraph Manufacturing Company, Limited, and the London Electric Wire Company, Limited, also co-operated in forming the Committee, and have adopted its recommendations.

The report of the Committee is as follows:—

(1) Resolved: That Matthiessen's standard of ·153858 standard ohms resistance for a wire one metre long, weighing one gramme at 60 deg. Fah., be taken as the standard for hard drawn high conductivity commercial copper.

(2) Hard drawn copper to be defined as that which will not elongate more than 1 per cent. without fracture.

(3) Resolved: That Matthiessen's standard of ·150822 standard ohms resistance for a wire one metre long, weighing one gramme at 60 deg. Fah., be taken as the standard for annealed high conductivity commercial copper.

(4) Copper to be taken as weighing 555 lb. per cubic foot at 60 deg. Fah., which will give a specific gravity of 8·912.

(5) Resolved: That Messrs. Clarke, Forde, and Taylor's temperature coefficient, as published in their pamphlet dated February 20th, 1899, be adopted, and that the average coefficient of ·00238 per degree Fah. be adopted for commercial purposes.

(6) Resolved: That the resistance and weight of conductors be calculated from the actual length of the wires.

(7) Resolved: That a lay of twenty times the pitch diameter be taken as the standard for the calculation of tables.

(8) Resolved: That 2 per cent. variation of resistance or weight be allowed in all conductors.

(9) Resolved: That an allowance of 1 per cent. increased resistance, as calculated from the diameter, be allowed on all tinned copper between Nos. 22 and 12 gauges inclusive.

Note to (1) *and* (3).—The figures inserted have been calculated for 60 deg. Fah. from the figures ·1469 per metre gramme for hard drawn, and ·1440 for annealed at 32 deg. Fah., by Matthiessen's formula.

$$R\ t\ \text{deg.} = \frac{R\ 32\ \text{deg.}}{1 - \cdot00215096\ (t - 32) + \cdot00000278\ (t - 32)^2}$$

A. H. HOWARD, Honorary Secretary.

From the above data the following formulæ are obtained:—

SOLID WIRES.

Copper weighs 555 lb. per cubic foot at 60 deg. Fah. Specific gravity = 8·912.

The resistance of annealed high-conductivity commercial copper is:—

Resistance per cubic inch	=	·00000066788 standard ohms.
Resistance per cubic c/m	=	·0000169639 " "
Resistance of 100′, weighing 100 grains	=	·156158 " "
Resistance per mile	=	$\frac{\cdot042317}{\text{Area in square inches.}}$
Resistance per yard	=	$\frac{\cdot00024044}{\text{Area in square inches.}}$
Resistance per mil. foot	=	10·2044 standard ohms.

The resistance of hard-drawn high conductivity commercial copper is:—

Resistance per cubic inch	=	·000000781327 standard ohms
Resistance per cubic c/m	=	·00000173054 "
Resistance of 100′ weighing 100 grains	=	·153181 "
Resistance per mile	=	$\frac{\cdot0431689}{\text{Area in square inches}}$
Resistance per yard	=	$\frac{\cdot0000245277}{\text{Area in square inches.}}$
Resistance per mil foot	=	10·4009 standard ohms.
Weight per mile	=	20,350 × area in square inches
Weight per yard	=	11·5625 " "

CABLES.

A lay of twenty times the pitch diameter is adopted as a standard, and the resistance in parallel of the wires is taken as the resistance of the cable.

Resistance of three-strand cable	=	·33742 ×	resistance of each wire
" four "	=	·253065	" "
" seven "	=	·1443557	" "
" twelve "	=	·084355	" "
" nineteen "	=	·0532424	" "
" thirty-seven "	=	·0273493	" "
" sixty-one "	=	·0165911	" "
" ninety-one "	=	·0111222	" "
Weight of three strand cable	=	3·03678 ×	weight of each wire.
" four "	=	4·04904	" "
" seven "	=	7·07856	" "
" twelve "	=	12·1471	" "
" nineteen "	=	19·2207	" "
" thirty-seven "	=	37·4414	" "
" sixty-one "	=	61·7856	" "
" ninety-one "	=	92·1034	" "

The above formulæ give the standards, but a variation of 2 per cent. in resistance or weight is allowed for losses in manufacture.

These figures have been adopted by all of the parties represented, and it is hoped that they may become the universal standard for Great Britain.

The measurements made by Dr. Matthiessen were for the purpose of determining the best metal to use for a standard resistance, and the permanence of the resistance was of more importance than the actual numerical value.

The specific gravity of the copper was not taken, and as the results are given by length and weight, they afford no means of determining the resistance of a wire of any given diameter. In addition B.A. units have been confounded with standard ohms, so that discrepancies have arisen from both causes.

The resistance of a stranded conductor varies according to the lay of the wires. Some makers use a lay of twelve times the pitch diameter, while others go so high as thirty times the pitch diameter; twenty was adopted as an average figure, and the resistances calculated from the actual length of the wires, viz., 1·01226 times the length of the cable for all except the centre wire.

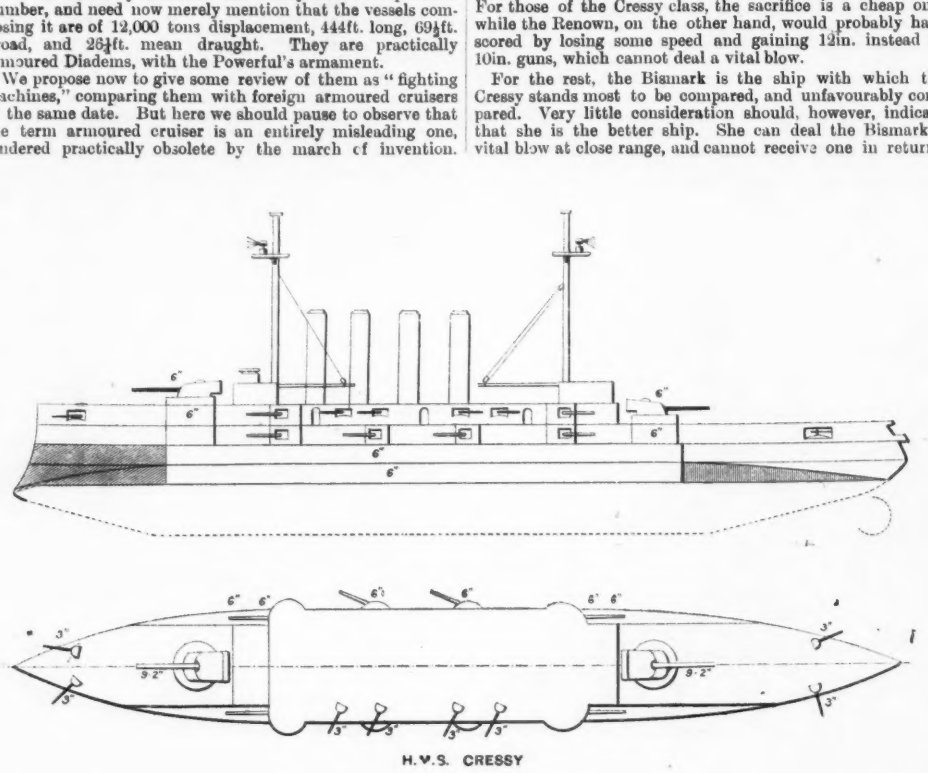
As the Post-office specifications will be issued in accordance with the above report, and as all of the manufacturers mentioned will include the same figures in their catalogues, there seems little doubt that these standards will be adopted throughout Great Britain.

THE Bridges Committee of the London County Council at the meeting on Tuesday presented a report respecting the partial service day and night at Woolwich Ferry. There are two boats, one running all day and the other during the night. The day boat from July 1st to December 2nd carried 221,825 passengers, 22,424 vehicles, and 1132 cattle; and the night boat 15,121 passengers, 619 vehicles, and 264 cattle. The Committee thinks that the Council will be justified in keeping the Ferry open day and night continuously at a cost of £2000 per annum. The Woolwich Ferry is a "highway," and the public should have the free use of it at all hours of the day, as in the case of an ordinary road. It makes a recommendation to that effect.

H.M.S. CRESSY.

WE have already described the Cressy class in a previous number, and need now merely mention that the vessels composing it are of 12,000 tons displacement, 444ft. long, 69½ft. broad, and 26¾ft. mean draught. They are practically armoured Diadems, with the Powerful's armament.

We propose now to give some review of them as "fighting machines," comparing them with foreign armoured cruisers of the same date. But here we should pause to observe that the term armoured cruiser is an entirely misleading one, rendered practically obsolete by the march of invention.



H.V.S. CRESSY

The Cressy, indeed, is an armoured cruiser pure and simple, designed to fill cruiser duties, which it is tolerably certain few foreign so-called armoured cruisers will ever be called upon to do. For instance, the German Furst Bismark and the Russian Peresviet, whatever they may be called, are to all intents and purposes second-class battleships like our Renown, which they closely resemble in many ways. The Japanese Asama class ships, again, are in reality third-class battleships. That is the prime use to which they will be put in the Japanese navy, and is indicated by their relatively small coal supply. The Japanese intend them to "lie in the line;" we have no such intention with regard to the Cressy class. Political considerations and the needs of the makers of statistics are between them responsible for much of the present *impasse*. The armoured cruiser proper was a craft like our Orlando, a cruiser which sacrificed some speed in order to gain some protection to its vitals. Now-a-days if we erect a high standard for battleships, the armoured cruiser is a battleship that sacrifices some guns or some protection for speed, an absolute reversal of the original idea. If we label consistently, then the Canopus and even the London classes are armoured cruisers. They are not intended for cruiser duties, however, so we call them first-class battleships, that other comprehensive and misleading term, which—statistically—includes the Barfleur, the Italian Sardegna—armoured cruisers, if ever the term was applicable—and the Italian Lepanto, which is actually nothing but a first-class protective cruiser of great magnitude. All this must be borne in mind in the following comparisons, which otherwise are bound to be misleading:—

Class of armoured ship.	III. Cressy.	III. Jeanne d'Arc.	III. Gromovoi.	II. F. Bismark.	III. Asama.	II. Peresviet.	II. Renown.	III. Belgrano.	III. Gloire.
Displacement	12,000	11,270	12,336	10,482	9700	12,674	12,350	7282	9367
Armament, 1st	2 9·2in. (B)	2 7·6in. (C)	4 8in. Q (C)	4 9·4in. (B)	4 8in. Q (C)	4 10in. (B)	4 10in. (B)	2 10in. (B)	2 7·6in (C)
„ 2nd	12 6in. Q (D)	14 5½in. (D)	16 6in. Q (D)	12 6in. Q (D)	14 6in. Q (D)	11 6in. Q (D)	10 6in. Q (D)	14 6in. Q (D)	8 5½in. (D)
„ 3rd	12 3in. Q (F)	none	20 3in. Q (F)	10 3·5in. Q (F)	12 3in. Q (F)	20 3in. Q (F)	8 3in. Q (F)	2 3in. Q (F)	4 4in. (E)
Submerged tubes	2	2	2	5	4	4	4	none	2
Above-water tubes	none	none	5	1	1	2	1	4	none
Armour—									
Belt, amidships	6in. (c)	6in. (c)	6in. (c)	7½in. (b)	7in. (b)	9in. (a)	8in. (b)	6in. (c)	6in. (c)
„ bow	4in. (f)	4in. (d)	none	5in. (d)	3½in. (e)	Belt extends to within 10ft. of bow	nil	4in. (d)	4in. (d)
Lower deck, amidships	6in. (c)	3in. (c)	4½in. (d)	nil	4in. (d)	6in. (c)	6in. (c)	6in. (c)	4in. (d)
„ „ bow	2in. (f)	2in. (f)	none	nil	3in. on torpedo tube in extreme bow	none	none	none	4in.–2in.
Casemates	6in. (c)	6in. (c)	6in. (c)	4in (d)	6in. (c)	6in. (c)	6in. (c) on main deck, the 4 on upper deck are 4½in. (d)	6in. c battery for 10 of the 14 6in. guns, other shields	4in. (d)
Number of 6in. guns in casemates	all	all in turrets	10 out of 16, shields to others	6, the rest in turrets	10 out of 14, shields to others	10 out of 11	—	—	all
Turrets or barbettes (big guns)	6in. (c)	6in. (c)	6in. (c) casemates	7½in. (b)	6in. (c)	10in. (a)	10in. (c)	6in. (c)	6in. (c)
Bases of big guns	6in. (c)	f to bow gun	6in. (c)	none	6in. (c)	10in. (a)	10in. (c)	6in. (c)	nil
Big gun shields	6in. (= a)	Turrets	Casemates	Turrets	6in. (c)	Turrets	= aa	6in. (= a)	Turrets
Coal carried, tons	800	1,400	?	?	550	1063	800	655	1,020
Coal capacity, maximum	1,500	2,000	2500	1,600	1,800	2058 + petroleum	1,600	1,000	1,600
Horse power	21,000	28,500	?	19 000	18,000	14,500	12 901	14,000	19 000
Extreme speed, knots	21	23	21	19	22	18	18·75	20	21
Armour deck	3in. (= c)	3in. (= c)	3in. (= c)	3in. flat	1½in. (= c)	2½in. (= c)	3in. (= c)	1½in. flat	2in. (= d)
Protection to vitals	= aaa	= aaa	= aaa	= a	= aa	= aaaa	= aaaa	= b	= an

In this table the naval war game notation of guns and armour has been appended, in order to save needless dissertations upon the penetrability of the various armours, &c. Under the head of "protection to vitals," the great difference between an ordinary and reinforced belt can be seen at a glance. It should be borne in mind, however, that the building of a, say Belgrano, with a curved deck behind the belt might be possible without any very great increase in displacement, although in this particular case it might necessitate considerable alteration in the design. Take it how we will, however, the Belgrano stands out as a wonderful ship, the protection to vitals being the only thing in which she is much behindhand. She has, of course, no submerged tubes, but the 6in. Harvey protection to those that she has renders them tolerably safe in action.

As regards the Cressy, it will be noted that the ship to which she most nearly approximates is the Renown. The 2in. less belt may be taken to represent the Cressy's 2in. on the bow water-line—the price of the 2¼ extra knots may be found in the barbettes 6in. instead of 10in., and two 9·2's in place of four 10in. pieces. The comparison is, of course, very relative; the ships are designed for quite different duties. For those of the Cressy class, the sacrifice is a cheap one: while the Renown, on the other hand, would probably have scored by losing some speed and gaining 12in. instead of 10in. guns, which cannot deal a vital blow.

For the rest, the Bismark is the ship with which the Cressy stands most to be compared, and unfavourably compared. Very little consideration should, however, indicate that she is the better ship. She can deal the Bismark a vital blow at close range, and cannot receive one in return; while the Bismark's armament, unprotected underneath, is armour protected to very little purpose.

DOCKYARD NOTES.

OUR readers may remember a recent controversy that THE ENGINEER had with *Le Yacht* concerning the Jeanne d'Arc. Our strictures upon that ship were by no means admitted. In this connection the following quotation from *Le Yacht* is not without interest:—". . . le Dupuy le Lôme, on trouve qu'il coute trop cher et on l'abandonne, ce qui fait qu'après la Jeanne d'Arc on revient en arrière, on arrive facilement á un resultat déplorable." Which is more or less the conclusion we came to in THE ENGINEER some months ago.

WE hear that the destroyer Earnest—one of the second batch of Birkenhead boats—which recently grounded at Tangier, managed to do 21 knots easily with one engine and two boilers just after the affair. This is pretty good, and seems to indicate that putting these craft out of action will be a good deal more difficult than is generally supposed.

THE German ironclad Wörth, which also ran aground some time ago, is now under repair. She tore a hole 22ft. long in her bottom, and flooded three compartments.

FROM Russia we learn that the Apraxin sustained very little damage when she grounded off Hogland. The four destroyers of the Sokol type building at Abo will be named Lebod, Pavlin, Phasan, and Pelikan. Another to be built at the New Admiralty, St. Petersburg, will be christened Albatross. All these boats are of 230 tons and 4500 indicated horse-power, and are practically replicas of the Sokol, built by Messrs. Yarrow, at Poplar.

IT has been decided not to convert the old single-screw United States cruiser Atlanta into a twin-screw craft, as originally contemplated.

THE trials of the Kentucky on a 66-knot course in bad weather produced a mean of 16·89 knots forced draught. The highest speed realised was 17·25 knots. At natural draught she did 360 miles in twenty-four hours, giving a mean speed of 14·9 knots. She worked up to 15·3 knots for a portion of the time.

OUR Essex class of armoured cruiser will carry a pair of 6in. guns in a single turret forward and a similar turret aft. Special mountings have been devised for these by Vickers, Sons, and Maxim, so that the two guns can be operated as one or independently. This device is new for the British Navy, though the Canet people evolved something of the same sort for their 15 cm. pieces some while ago, and the system has, we believe, been adopted for the Russian navy.

THE two projected big French armoured cruisers will not after all be built—anyway not at present. Like the big battleships, they have been countermanded.

WORKMEN'S COMPENSATION CASE.

November 24th.—Court of Appeal.—Plaintiff, Hensey; defendant, White. This was an appeal from the decision of the Bradford County-court. The only question was whether the death of the workman was caused by an accident, the Act only applying where there was personal injury by accident to a workman. The appellant was the widow of a cabinet-maker named Charles Hensey, who at the time of his death was in the employment of the respondent. It appeared that the workmen had to begin their work of a morning by starting a gas engine. Upon the first day after the Christmas holidays, 1898, when the workmen resumed work, Hensey and three other men proceeded to start the engine. In order to start the engine it was necessary to turn a large fly-wheel. Hensey proceeded to attempt to hoist the wheel, the three other men pulling it down the other side. Owing to the lapse of time since the engine was last used, difficulty was experienced at first in making the wheel move, at last the men succeeded in moving the wheel, when Hensey suddenly put his hand to his stomach and left the place. He was found immediately afterwards vomiting blood, and he bled to death. Death was caused by rupture of the small blood vessels of the stomach and intestines. The deceased man had been employed on the work for several years. A *post-mortem* examination was made, and the medical evidence showed that the deceased man had been suffering from chronic indigestion, which had weakened the blood vessels of the stomach and the intestines, and there was evidence of congestion and inflammation. Two of the doctors gave it as their opinion that the rupture of the blood vessels was caused by the strain, whereas another doctor stated his opinion that the strain apart from the disease did not cause the blood vessels to give way, and that, in his opinion, hæmorrhage of the stomach could not result from strain without disease. The County-court Judge found that to make it an accident there must be something happening beyond the mere fact of a disease suddenly taking a fatal turn—*e.g.*, some break in the machinery, some fall of the workman, or something else out of the ordinary and normal course of the workman's employment. It was not enough that ordinary hard work, carried on by the workman in the manner intended, had, as he worked, suddenly caused his disease to take a fatal form. He found as a fact that the deceased man had been long suffering from chronic inflammation of the internal coat of the stomach, caused or accompanied by congestion of the numerous small blood vessels in that coat, that there was an exudation of blood from the stomach which caused death, and that this was the result of the congestion and chronic inflammation of the stomach, and would not have happened without it. He accordingly decided in favour of the defendant.

It was contended for the plaintiff that the actual and immediate cause which produced death could alone be looked at. The predisposing cause of death could not be looked at. The County-court Judge really only found that without the disease the strain would not have caused death. That was not a finding that the disease was the proximate cause of the death. The strain was the proximate cause, and that was an accident. The defendant's counsel was not called upon.

The Court dismissed the appeal.

LORD JUSTICE A. L. SMITH said that the question was whether, upon the findings of the County-court Judge, the death of the workman was caused by accident. The man was at his ordinary work and the wheel of the gas engine had to be started. The wheel happened to be rather stiff, and there was some difficulty in starting it. When attempting to start the wheel the deceased man suddenly put his hand to his stomach and left the place, and he died from the bursting of blood vessels in his stomach. Upon the *post-mortem* examination it was found that the stomach was not at all in a sound condition. Medical evidence was given on both sides as to the man's condition, and the Judge upon the evidence found that the death was caused by disease, and that the rupture of the blood vessels probably was caused by the man's ordinary work, though upon the occasion in question the work was a little more arduous than usual. The Judge came to the conclusion that the disease and not an accident caused the death. They could not interfere with that finding of fact. The appeal must therefore be dismissed.

LORD JUSTICE COLLINS concurred. It was clear on the findings of the County-court Judge that the element of accident was entirely wanting. The injury arose in the ordinary course of the deceased man's work, though there might have been a little more exertion used by him in that work on the occasion in question than was usual. Lord Halsbury had said that he thought that the idea of something fortuitous and unexpected was involved in the word "accident." That element was wanting in the present case.

LORD JUSTICE VAUGHAN WILLIAMS concurred.

CONTRACT OPEN.

SIAMESE STATE RAILWAYS.

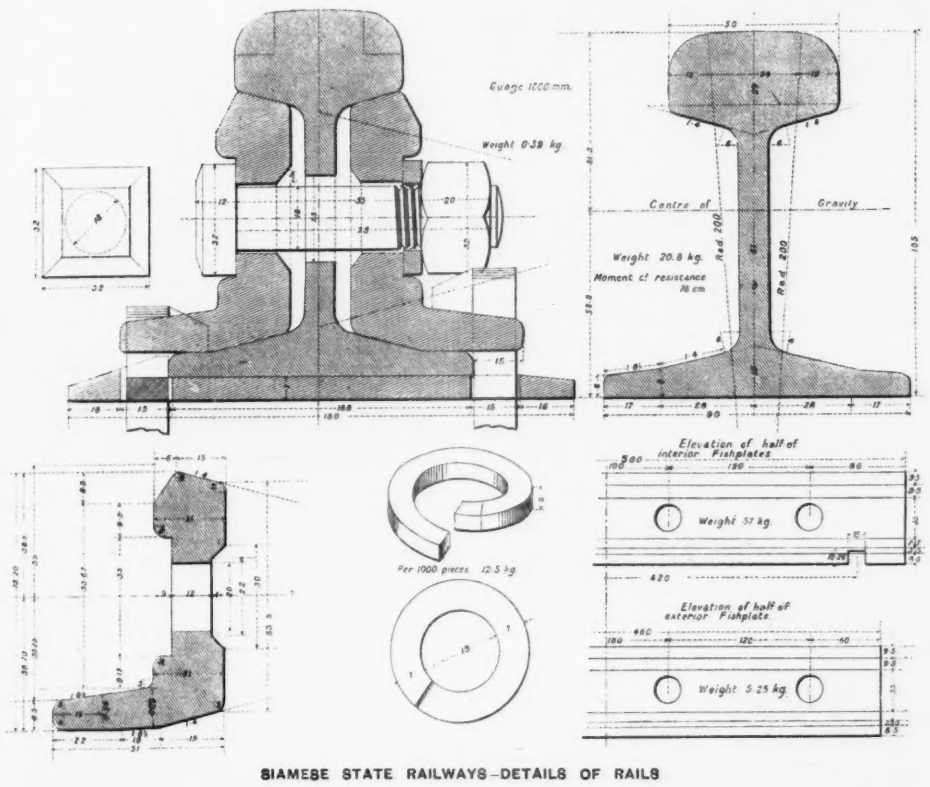
TENDERS are invited for permanent-way materials for the Siamese State Railways, in accordance with the accompanying drawings and table. The contract comprises the supply and delivery at Bangkok of the following:—6739 tons of Bessemer steel rails, in lengths of 8 metres, weighing 20·8 kg. per metre, with short lengths for 80 crossings; 187 tons of iron spikes, weighing 0·18 kg. each; 446 tons of angle fish-plates, of either Bessemer steel or ingot iron—Flusseisen—weighing 11 kg. per pair; 66 tons of gudgeon fish-bolts with nuts, weighing 0·39 kg. each; 2·2 tons of split washers, weighing 12·5 kg. per thousand; 161 tons of ingot iron—Flusseisen—bearing plates, weighing 1·3 kg. each. Price each, in marks, is to be stated in one column, and totalled in another column. Contractor is to state in his tender whether the goods will or will not be manufactured on his own premises.

Payment will be made through the Leipzig Bank as follows:—One-fifth down, three-fifths against bills of lading, and the remaining one-fifth after the whole of the materials have been delivered in Bangkok: 10 marks will be deducted for every working day that any portion of the contract remains undelivered over the specified time. The contractor is to furnish invoices within four days of complete delivery, in default of which they will be prepared by the directors of the State Railway.

Contractor is to guarantee the work for twelve months, counting from the last day of the month in which final delivery is made.

Contractor is to pay the stamp duty on the contract, but the direction will pay half the expenses of the preparation of contract bond.

Tenders marked "Angebot auf die Lieferung von Oberbanmaterialien für die Siamesischen Staatseisenbahnen," addressed to Herrn Baurath Rehbein, No. 2, Blücher-Strasse, Leipzig, where they must be received by eleven o'clock on the morning of the 28th December, 1899.


Gauge 1000 mm.
Weight 0·39 kg.
Centre of Gravity
Weight 20·8 kg.
Moment of resistance 76 cm
Per 1000 pieces 12·5 kg.
Elevation of half of interior Fishplate
Weight 5·7 kg.
Elevation of half of exterior Fishplate
Weight 5·25 kg.

SIAMESE STATE RAILWAYS—DETAILS OF RAILS

Radius of curve of the railway line, m.	3000	2000	1500	1000	900	800	700	600	500	450	400	350	300	250	200	180	160	140	
Number of bearing plates for 8 m. length of way	6	6	6	7	7	8	8	9	10	10	12	12	14	14	14	14	14	14	
Number of bearing spikes for 8 m. length of way	50	50	50	51	51	52	52	53	54	54	56	56	58	58	58	58	58	58	
Rise of exterior rail in curves, mm.	0	0	3	5	6	7	8	9	10	12	13	15	17	21	26	29	33	37	5200 / R mm.
Difference in length between exterior and interior rail, mm.	3	4	6	8	9	10	12	14	17	19	21	24	28	34	42	47	52	60	
Proportion of shorter rails of 7·95 m.	1/2	1/3	1/5	1/7	1/8	1/10	1/11	1/13	1/15	1/17	1/19	1/21	1/23	1/27	1/33	1/37	1/41	1/47	of all lengths
Proportion of normal 8 m.	39/40	37/40	35/40	33/40	32/40	30/40	29/40	27/40	25/40	23/40	21/40	19/40	17/40	13/40	7/40	3/40	1/40	1/40	
Increase of gauge in mm.	0	0	0	0	0	0	0	0	3	4	5	8	11	14	17	19	20	25	

ELECTRIC RAILWAYS IN BERLIN.

ALTHOUGH no details appear as yet to have been published concerning the forthcoming experiments with electric traction on a short section of the Metropolitan and District Railways, it is interesting to note that a similar scheme has been elaborated in regard to the Metropolitan and Circle railways in Berlin. The traffic on both these lines has considerably increased during the past few years, and in the case of the Metropolitan Railway it is estimated that the limit of its carrying capacity has already been reached, and that it will be impossible to deal with future developments of the passenger traffic. In these circumstances the Union Electricity Company has devised a scheme for the conversion of the lines to the electric system in such a manner that the existing buildings and permanent way would be but little altered, whilst at the same time a higher speed would be attained and increased accommodation provided for passengers. The scheme proposes the introduction of trains each composed of eight four-axled motor cars having a total passenger accommodation to the extent of 80 per cent. more than in the case of the present carriages of the steam railway, the trains on which consist of nine two-axled coaches and locomotive. Each electric train would therefore be equivalent to 14·4 passenger coaches of the existing type, the limit of eight motor cars being selected in order to meet the requirements incidental to the length of the station platforms. The rapidity with which it is possible to attain a high rate of speed would allow of the sections between the signal cabins being traversed in a much shorter period, so that it is calculated that trains could follow each other at intervals of two minutes instead of three minutes as is the custom at the present time. The use of larger carriages and the increase in the speed of the trains are expected to augment the carrying capacity of the railways to the extent of 260 per cent. With regard to the generating plant, the first instalment of the scheme provides for the erection of two large direct-current power stations each having an output of 7500 kilowatts, whilst at each railway station would be installed a battery of accumulators for the purpose of equalising the load, and at the same time serve as reserve in case of any temporary interruption in the supply from the generating stations. The current would be collected from a third rail laid between the rails by means of sliding shoes, and each car would be equipped with two motors of 175-horse power each, in another column. Contractor is to state in his tender whether the goods will or will not be manufactured on his own premises.

Payment will be made through the Leipzig Bank as follows:—One-fifth down, three-fifths against bills of lading, and the remaining one-fifth after the whole of the materials have been delivered in Bangkok: 10 marks will be deducted for every working day that any portion of the contract remains undelivered over the specified time. The contractor is to furnish invoices within four days of complete delivery, in default of which they will be prepared by the directors of the State Railway.

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A FAST RUN WITH A HEAVY TRAIN.

THE Lake Shore and Michigan Southern Railway has recently put in service a number of the largest express engines ever built, designed for hauling trains of 350 to 500 tons—behind the tender—at speeds of over 50 miles per hour. These engines are of the ten-wheel type, or six-coupled bogie engines, having cylinders 22in. by 28in., and driving wheels 6ft. 8in. diameter. On November 22nd one of these engines made the run of 183 miles from Buffalo to Cleveland in 3 hours and 26 min., of which 16 min. were occupied by stops for water at three intermediate stations. This gives a speed of 58 miles per hour for the entire run, while 7 miles were made at 83¾ miles per hour and 41 miles at 65 miles per hour. The train consisted of two sleeping-cars, five post-office cars—on six-wheeled bogies—and two ordinary coaches, the total load being about 510 tons, or 650 American tons = 580 English tons with engine and tender. The run was made with a heavy side wind blowing. The record is as follows:—

	Miles.	Times. Hrs.	min.	Speed Miles per hr.
Buffalo to Dunkirk	40	0	46	52
Do. to Erie	88	1	35	55
Do. to Ashtabula	129	2	13	58
Do. to Cleveland	183	3	10	58
Dunkirk to Erie	48	0	49	58¾
Erie to Ashtabula	41	0	38	65
Ashtabula to Cleveland	54	0	57	57

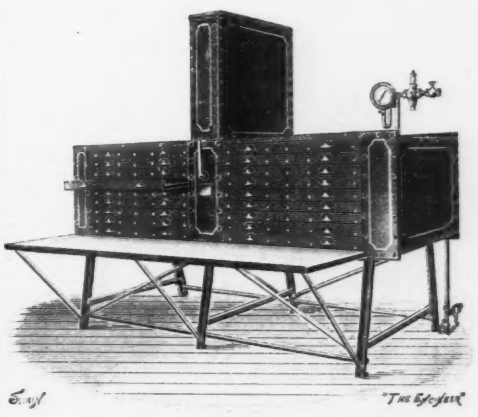
The full time record is as follows:—

		Miles.	Time p.m. Hrs.	min.
Buffalo	leave	0	7	24
Buffalo Creek		—	7	31
West Seneca		—	7	35
Athol Springs		9	7	39
Lake View		14	7	44
Angola		22	7	51
Farnham		26	7	55
Silver Creek		32	7	59
Dunkirk	arrive	40	8	10
Do.	leave	40	8	15
Van Buren		—	8	21
Brocton Junction		49	8	26
Westfield		58	8	34
Ripley Crossing		—	8	26
Ripley		65	8	42
North-East		73	8	50
Harbour Creek		80	8	56
P. and E. R. R. Crossing		—	9	01
Erie	arrive	88	9	04
Do.	leave	88	9	10
Swanville		—	9	19
Girard		103	9	25
Springfield		108	9	29
Conneaut		116	9	35
Kingsville		123	9	43
Ashtabula	arrive	129	9	48
Do.	leave	129	9	53
Geneva		138	10	03
Madison		144	10	08
Perry		149	10	13
Painesville		154	10	18
Mentor		161	10	23
Willoughby		165	10	27
Wickliffe		169	10	31
Nottingham		174	10	35
Glenville		—	10	38
Cleveland	arrive	183	10	40

There are several gradients of 1 in 210 to 1 in 170 for lengths of quarter-mile to one mile.

SUTTON'S "SAFETY" TEA DRYER.

THE accompanying engraving represents an improved form of dryer that has been lately introduced by G. W. Sutton, of the Blaxton Engineering Company, Limited, London, for



drying tea, cocoa, and other substances that require a constant even temperature. The apparatus shown consists of an iron casing, having sixteen trays arranged to slide in and out, which carry the material to be dried. Under each tray is placed a coil of steam pipe, each coil being connected by a vertical supply and discharge pipe. On the discharge pipe is placed a steam trap, shown to the right back corner; besides the trap a by-pass is arranged for allowing the cold water to flow away freely when first starting the dryer. On the steam supply pipe is placed a reducing valve and steam gauge; in the centre of the machine is placed a thermometer.

The latter is considered by the makers to be unnecessary, nor can it register the correct temperature to which the material being dried is subjected. The greatest heat will be given off from the coils immediately under the trays, where the thermometer ought to be placed; but this, of course, is impracticable.

In its present position the thermometer registers the temperature of the air after it has done its work, instead of before; under the circumstances the manufacturers recommend that the thermometer be dispensed with altogether, the steam gauge only being sufficient to indicate the temperature, as the pressure of the exact temperature is regulated by the reducing valve. Reports submitted by tea planters who are using these dryers testify to the excellent results obtained, while they are said to be economical in the consumption of fuel.

IT is reported that asbestos has been discovered in the southern province of Ceylon, thus opening up a new industry.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions o our correspondents.)

ELECTRIC LIGHTING AND REFUSE DESTRUCTORS.

SIR,—The letter from Mr. J. W. Baker which appeared in your issue of the 8th inst. contains some very curious errors. For instance, he says that you, Mr. Editor, say "that 23,728 tons of refuse were incinerated at a total cost of £8364," whereas, having read your article, I have been quite unable to find any such statement. As a matter of fact, the quantity of refuse incinerated during the financial year covered by the Shoreditch report was, according to Mr. Newton Russell, the engineer to the undertaking, 26,201 tons, while the figure mentioned as the cost, namely, £8364, includes very large sums indeed which have nothing to do with that financial year.

The financial year is from March 25th, 1898, to March 25th, 1899, but the £8364 mentioned by Mr. Baker includes cartage and disposal of clinkers from April 2nd, 1897, to September 29th, 1897; electricity supply from June 24th, 1897, to March 25th, 1898; interest on mortgage debt for three years up to March 25th, 1898; repayment of mortgage debt, three years' instalments towards repayment of debt to March 25th, 1898. These statements are taken from the page of the Shoreditch dust destructor accounts which contains the figure £8364, which Mr. Baker has mentioned as the cost of disposing of the refuse for the current twelve months. They are not mixed up with the general expenses of the year, but are put under a sub-heading, entitled "Extraordinary Expenditure," it being made as clear as accounts can make anything that they do not any of them belong to the twelve months in question, though for some reason or other it has been necessary to bring them into the account. Further, while these amounts are entered on the debit side of the account, they are more than met by an entry on the credit side.

More than that, Mr. Baker states that the repayment of the capital for the year was £980. I find on the page of the accounts in question that the repayment of capital for that twelve months was £809 odd, while the repayment of capital for the time preceding March 25th, 1898, as mentioned on the same page, was £171 odd. Omitting the oddments, this makes exactly £980, the amount of repayment spoken of by Mr. Baker. Either Mr. Baker must have known that that £8364 included very large amounts belonging to preceding years, or he never examined the figures for himself, but must have taken them on trust and without examination from somebody else.

In the latter part of his letter Mr. Baker states that 23,728 tons of refuse produced 12.225 tons of clinker and ash, carted away at a total cost of £1460. I have shown that the total amount of refuse consumed was 26,201 tons, of which it would appear, from the amount paid for destroying the refuse to the dust and scavenging department, that 23,728 tons was domestic refuse, the balance of 2473 tons being presumably trade refuse, for the destruction of which £278 odd was paid by private individuals to the Vestry. Trade refuse, however, produces clinker and ash, just as domestic refuse does, and the clinker and ash to be dealt with are therefore from the total of 26,201, and not only from the 23,728 tons of domestic refuse.

Mr. Newton Russell states in his paper read at the Institute of Civil Engineers on the 12th inst. that the amount of clinker and ash from the refuse was 32·8 per cent., or not quite one-third the weight of the refuse. This would amount to slightly under 9000 tons, or allowing for some addition to the weight from the slacking with water of the clinker for the purpose of cooling it and avoiding dust, say, about 9000 tons. Where does Mr. Baker get his 12,225 tons from? Some light is thrown upon this by his statement that the cost of carting it away was £1460. In the Shoreditch accounts, on the page already alluded to, it appears that the carting of clinker and ashes under contract for the twelve months cost £910 odd, and that the cartage and disposal of clinkers from the 2nd April, 1887, to the 29th September, 1897, cost £550 odd, making together Mr. Baker's £1460, so that we at once find that considerably over one-third of the total cost referred to is for dealing with clinkers in 1897, and no doubt a large part of the weight of the clinker quoted by Mr. Baker belongs also to that year.

Mr. Baker professes to criticise a certain report made by Messrs. Paton, Ransom, and myself, and also some of the figures which appear in the Shoreditch dust destructor accounts. Having shown to what extent Mr. Baker is inaccurate when figures are there before his eyes, or ought to be, it is useless to deal with his criticisms, which are largely suppositions. It has been shown already that the dust destructor installation at Shoreditch not only pays interest on the capital borrowed to erect it, together with instalments in repayment sufficient to extinguish the capital entirely in a reasonable time, but that it also yields a considerable advantage to the ratepayers. The figures Mr. Baker himself gives, although apparently inaccurate, would show that the report in question under-estimated the revenue to be obtained from the destructor, and if the cost of dealing with the refuse has been somewhat higher than was expected, it must be remembered that the cost of labour has enormously increased. At the time when the report was given destructors were universally, or almost universally, worked by two shifts of men per twenty-four hours. At Shoreditch they are worked by three shifts, and the payment for each man per shift is greater than it would have been at the time the report was made, notwithstanding that the number of shifts has been increased from two to three. There are also other special reasons for increased cost, some of which are disappearing, and will to a far greater extent disappear in the future.

I am sorry to trouble you with another letter on this subject, but the figures given by Mr. Baker are so exceedingly misleading and delusive that it appeared desirable to show that they had no support in actual fact.

JAMES B. ALLIOTT.

Nottingham, December 18th.

THE EFFICIENCY OF STEAM ENGINES.

SIR,—I am glad to see by Dr. Thurston's letter to you in your last number that he appreciates the table of twenty-nine modern economical steam engine tests, published by you on October 13th last. These were all condensing engines, having two, three, or four cylinders, and all tabulated in the same order. Just criticism is always acceptable, and particularly from such a high authority in the States as Dr. Thurston. I pointed out at the time—page 377 of your issue of October 13th—that the order of merit should not be "pounds of steam per indicated horse-power per hour," but "heat efficiency in thermal units." This was laid down by the Institution of Civil Engineers' Committee as the best figure of comparison for steam engines, but in the particular figures returned by the different experimenters it was seldom given. Since the publication of this table I have obtained further information, and calculated the various thermal units expended per indicated horse-power per minute, and also the thermal efficiency in each case. To do this I have assumed in all cases 2½ lb. exhaust pressure absolute, which is equivalent to a temperature of 134½ deg. Fah. as the lower limit of temperature. These new figures make little difference to the order of merit given for the different engines. Of course, the actual exhaust temperature from the last cylinder in each case should be taken, but this was not given by those who made the test. Perhaps Dr. Thurston will kindly let us have a revised table arranged in the order of merit which he would prefer; first, taking the steam engine alone, apart from the rest, and then, secondly, arranged in order for the whole plant, adding any new and good tests he knows of, not included in the table. Such would be both interesting and instructive, and would probably give rise to some good opinions. Of course we are all agreed that it is quite useless to give pounds of coal unless its heating value is added. The condensers usually attached to any steam engine can be considered as a separate apparatus, having its own heat efficiency, but this is rather an unusual way of looking at the question. In cases where all the hot-jacket water from many traps and the exhaust steam, after leaving the last cylinder, are used, and very economically, for heating feed-water going to the boilers, a careful balance-sheet in thermal units should be made out in a debtor and creditor account.

The most economical engine in the table was the Sulzer triple-condensing, which consumed 10·7 lb. of steam per indicated horse-power per hour, including jacket water; thermal units per indicated horse-power per minute, 196; thermal efficiency, 21¾ per cent. This with about 23½ expansions, and a piston speed of about 600ft. per minute. Many other cases in the table come very near these figures.

When the number of thermal units per minute of heat actually expended in any steam engine per indicated horse-power—or, better, per brake horse-power—is obtained, say, for instance, 196, a comparison can be made with any gas or oil engine. In some tables I have lately made of many good gas engine tests, the best result is 158 thermal units expended per indicated horse-power per minute = 27 per cent. heat efficiency. The best oil engine test is 124 thermal units per indicated horse-power = 34 per cent. heat efficiency. A good oil engine often gives 20 per cent. and 21 per cent. heat efficiency. These gas and oil engines are much smaller powers than those working with the steam engines mentioned in the tables.

It is much to be desired that the American Society of Mechanical Engineers, who have done for so many years such excellent work in standardising steam boiler tests, should organise a committee for engine tests, with blank sheets, regulations, and instructions. I hope Dr. Thurston will help in carrying this out on his side of the Atlantic. A committee of the Institution of Civil Engineers, London, is now doing such work for steam boilers and engines on this side, and have had many meetings. A committee of the Verein Deutsche Ingénieure in Germany has also had many meetings with the same object, and for modernising and standardising steam engine and boiler tests for the future, and these reports may be expected before long.

I trust that engineers will use thermal units more for steam, gas, and oil engine tests, and always return their heat efficiency, and also the latter for steam boiler tests.

Reigate, December 19th. BRYAN DONKIN.

ECONOMICAL HAULAGE.

SIR,—There is one point in this controversy of perennial interest which I should like to see particularly emphasised. American railroad methods may or may not be economically sound and best suited to American conditions; it may or may not be the fact that American methods applied in England would give better results commercially than are now obtainable. These things are no doubt a matter for argument; but surely, once the management of a railway has decided, whether wisely or otherwise, in what particular manner its traffic is to be got through there can be no two opinions as to the wisdom of building engines able to deal with whatever is likely to be put before them. Now I say, without fear of contradiction, that, speaking generally, the American locomotive, whatever its faults, is perfectly equal to its work, whilst the English engine, as far as the passenger department is concerned, is not. I have this summer and autumn travelled over thousands of miles of United States and Canadian railways, and never once, from the Atlantic to the Pacific—except on the very heavy inclines in the Rocky Mountains—have I seen a pilot engine required; and never once did I travel by any train, whatever its weight, on which the engine was unable not only to keep time unaided—that was taken as a matter of course—but also to make up any time within reason which had been lost owing to delays *en route*. By way of contrast to the magnificent locomotive work on the other side of the water, I found on returning to Liverpool and going north by the London and North-Western Railway that the train by which I travelled, of perhaps half the normal American weight, was, as usual, run "double headed" from Preston to Carlisle, although the train engine was one of the latest of the "John Hick" type, costing who knows what to build and maintain.

From time to time mysterious reports find their way into the press that some English company is building a new type of engine which will render the employment of pilot engines a thing of the past, but somehow these new types generally fail in attaining their object, and piloting goes on merrily as before. It has been urged that, as most of our trains are only really heavy for a short period of the year, it is better policy to build engines which are admittedly too small for their work during the busy season, on account of their superior economy at other times; but, as there are many trains in this country which require piloting all the year round, big engines should surely be provided for these at all events.

For instance, had an intelligent American visitor been at Euston one evening this week, he would have seen that a brand-new four-cylinder compound, of the latest Crewe pattern, required help all the way to Crewe on the 5.30 Manchester and Liverpool express, even on a miserable December night, on which it is safe to say no one would be travelling except under compulsion; and, by the way, he would also have noticed that "our premier railway" is not ashamed to send out one of the most important trains in the kingdom with no more protection against the bitter winter weather we have been experiencing than is afforded by a few hot-water cans.

It is nonsense to say that the loading gauge prevents the building of an efficient engine. Our own Caledonian Company has proved that, and if any English line, instead of merely ordering a few goods engines, would give American builders—or Alsatian or Swiss for the matter of that—a free hand to build them the best passenger engine the dimensions of the road would allow, I believe that the results would be as valuable as they would be instructive.

It is unfortunately a fact that, in everything connected with passenger traffic, from the splendid air brake—fancy trying to work long trains over inclines of 1 in 20 with nothing but the English vacuum brake to rely on, and a normal barometer pressure of 24in.—to the rose water in the finger bowls in the dining cars, American railways are so infinitely superior to our own that no comparison is possible, and the sooner the English companies can be brought to realise this unpleasant fact the better it will be for travellers and shareholders alike.

Devonshire Club, St. James's, S.W., December 16th. W. B. THOMPSON.

SIR,—I have been reading with much interest some of the letters in THE ENGINEER, in regard to train haulage in America and Great Britain. Not being an engineer, or connected in any way with that trade, it may appear presumptuous on my part to voice my sentiments on the subject; but, as a simple onlooker, it has struck me, after seeing the powerful engines of the N.Y. and H.H.R.R. drawing fifty and over freight cars, presumably most of them loaded, that the engines and trains here are like toys. I stood on the platform of one of the large stations in England not long since, and witnessed two mineral trains pass through at a very slow speed, engines puffing and snorting with a train of less than twenty cars. Several of those cars had the names of the one party painted on them, showng that two big American ones would have carried the whole individual load. The great distance between the cars struck me as so much space and power wasted.

The practice of using open cars for carrying baled goods, &c., is also primitive, and there can be no question that the accident at Norton Bridge would never have happened had the box car been in use, but no notice has been taken of this in any of the reports I have seen. A very much similar accident happened some years ago on the Dundee and Arbroath Joint Railway, though I believe no lives were lost.

I read Mr. Holmes' letter of the 15th inst., and fully agree with him on the comfort of the American passenger cars in winter, and the perfection of misery to be attained by riding in the ones here.

I recently travelled—early in November—from Glasgow south, and the misery of the trip I will never forget, even though it was taken in the much-praised corridor train. Railway men finally, at Carlisle, attempted to raise the temperature by introducing the antiquated warming pan. Why do not some of the leading railways, or all of them, in fact, acknowledge the very great superiority of the American car, and introduce trains built on that plan, viz., wider, with centre aisle, high roof, comfortable seats, well heated by steam, even as early as September month, when days and nights are so often chilly, and one class of car all through being used? I am sure the Britisher would soon get out of his privacy idea from the comfort he would enjoy.

I am a British subject, but have lived several years in the United States, and will sink my patriotism in stating simple facts. I do hope the day will soon come when we will cease to read of the importation of engines and machinery simply by our own up-to-dateness, and without any protective tariff to do it for us.

December 19th. GEE.

SIR,—The following extract from the *Berliner Tageblatt* will show that not England alone is behind the United States. The words quoted are those of a German steel manufacturer, who recently visited the United States:—"The industries have at their command a railway system which far surpasses in cheapness and efficiency of service anything known in Europe. The first sight of the tracks and equipment of an American railroad makes upon a German an imposing impression. Their freight cars of all classes far surpass in size and carrying capacity those of the German railways. Their track system is relatively broader and stronger than ours. Special tracks for freight trains secure rapid, almost unbroken traffic. A widely developed system of branch and side railways—feeders—sustains the traffic of the principal lines. While on the German railways the cost of freight per ton kilometre is—excepting some unimportant special tariffs—2·2 pfennigs, in America the corresponding rate is only 0·6 pfennig per ton kilometre." X.

Westminster, December 18th.

SIR,—Lest inordinate stress be laid upon the argument that substantial economy cannot be effected in transportation on British railways on account of the great relative cost of terminal service, it may be well to point out that the duty of these railways in connection with traffic in minerals and material for the heavy trades is confined to the working of full truck loads from the producers' to the buyers' sidings, and to the consequent return of empties.

One may as profitably beat a dead horse as spend time in answering the argument that such traffic is best conducted in small wagons by means of low-powered engines, irrespective of the object lesson of the failure of our railways to deal promptly with existing traffic by such methods.

A difficulty needing solution is the question of providing for the capital cost of alterations, when such are necessary, in private sidings and terminal plant. It is hardly to be expected that the British trader will act on his own initiative in the hope of eventually securing some concessions in his rates, though the immediate saving in the labour of shunting, unloading, &c., will in many cases render the outlay remunerative, apart from the saving to the railway company in working expenses.

J. D. TWINBERROW, A.M. Inst. C.E.

Newcastle-on-Tyne, December 20th.

THE METAPHYSICS OF PHYSICS.

SIR,—I have neither the time nor the capacity to go deeply into questions regarding the ether. I venture to hint at a solution of the light problem, which may be old, or it may not; I have not met with it. It is a modification of Newton's corpuscular theory.

It is generally admitted that there are grave difficulties connected with the undulatory theory, and these have been accentuated by the discovery of the Röntgen ray, phosphorescence produced by it, and other phenomenon. More than one authority appears to hold that these effects are produced by the despatch of corpuscles through the glass. The corpuscular theory is not yet quite dead.

The objection to the corpuscular theory is that it is inconceivable that any particle of matter should, when flying at 198,000 miles a second, come in contact with the eye without destroying it.

But let us suppose a chain of perfectly elastic little spheres extending from this to the sun, all in contact, like a row of pyramid balls on a billiard table. An impulse given to the one next the sun will then be transmitted through the whole chain without change of place in any of them, and so the last will act on the eye. The rate will depend on the coefficient of elasticity of the molecules.

It would be presumptuous on my part to go on to show how this theory works out for polarisation, &c. LUX.

London, December 16th.

RAILWAY SPEEDS.

SIR,—An examination of the express trains on the London and North-Western Railway of over fifty miles an hour average speed shows that our leading line is not only maintaining but increasing its express mileage. In May, 1897, there were 75 trains with a total mileage of 4597½ miles, or an average of 61·3 miles per train, while to-day there are 102 with a total of 6662½ miles, or 65·3 per train. Comparing this with the table given on page 463 of THE ENGINEER for November 10th last, we find that while the Northern of France Railway has twelve trains faster than our best, there are only 45 trains with a total of 3044 miles, or an average of 67·4 per train. It will be noticed the postal and American special trains are not included in the list. SYDNEY SHEDDEN.

7, Ryder-street, Cardiff, December 15th.

AN APPRECIATION.—We hear that in recognition of old employes' long and faithful services, Mr. John Gwynne, the head of the firm of J. and H. Gwynne, Limited, of the Hammersmith Ironworks, has just assigned to them 1000 fully paid-up shares in the company. The participants number nearly forty, and comprise engineers, fitters, turners, planers, shapers, slotters, moulders, pattern-makers, and labourers. According to the deed of gift, a copy of which has been handed to each man, the dividends are to be divided among them and paid half-yearly. The only conditions imposed are that the men shall continue working for the firm unless incapacitated by illness or accident, and that upon the death of a participant his relatives shall have no claim.

CHARLES MORRIS JENKINS.—Amongst the officers reported killed at the battle of the Tugela is Lieut. Charles Morris Jenkins, A.M. Inst C.E., of Thornycroft's Light Infantry. Lieut. Jenkins was the third son of Mr. Thos. Jenkins, of Dowlais, and was thirty-two years of age. He left home several years ago, and was engaged by the Natal Government on the construction of the railway from Ladysmith to Harrismith, and afterwards upon the line from Charlestown to Heidelburg. Recently he was one of the principal district engineers for the contractors of the Pretoria-Pietersburg Railway, and was still engaged on that line when he was compelled to leave the Transvaal. On reaching Natal he enlisted in Thornycroft's Mounted Infantry, with several of his late railway companions.

THE INSTITUTION OF CIVIL ENGINEERS.

COMBINED REFUSE DESTRUCTORS AND POWER PLANTS.

AT the ordinary meeting on Tuesday, the 12th December, Sir Douglas Fox, president, in the chair, the paper read was on "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc. M. Inst. C.E.

The paper dealt with the subject of refuse destruction, particularly in reference to its employment for raising steam; and gave details of ten combined plants, the data of which all tended to prove that a considerable amount of energy in the form of heat was to be obtained from the burning of ordinary domestic refuse. The results obtained from eight combined plants in England and abroad were given; the Shoreditch plant being dealt with in considerable detail, as being the largest of its kind in operation.

The total amount of refuse destroyed during a period of twelve months was about 26,000 tons, of which 92 per cent. was ordinary domestic refuse, and 8 per cent. trade refuse, consisting of straw, paper, &c. &c. The latter was practically useless for steam raising. The plant consisted of six Babcock-Willcox water-tube boilers, and twelve refuse furnaces of the Manlove-Alliot type, each boiler being placed between two refuse furnaces, the hot gases from which were led into the boiler tubes through short side flues, each boiler being provided with a special grate, on which coal might be burned if required. The refuse, on arrival at the works, was carefully weighed, and was afterwards shot, without sorting, into trucks which were raised by electric lifts—of which there were two—to the top platform. On arrival at this point the truck, which was on wheels and fitted with an electric motor, was run off the lift, on the overhead-trolley system, to any position where it was desired to empty it; the refuse was then tipped into special charging trucks, one of which was provided for each furnace, and which was operated from the top platform by means of chain gearing. The average amount of refuse received per day was 84 tons, delivered between 9 a.m., and 5 p.m., although as much as 140 tons had been received in one day. It appeared to be impossible in ordinary working to guarantee a regular supply, and it was advisable to provide means of storage to cope with extra large deliveries. This difficulty was met at Shoreditch by means of a large rectangular iron storage bin fixed under the tipping platform, and holding about 60 tons of refuse. The lifts and trucks were operated entirely by electricity. Forced-air draught was supplied to the fires by electrically-driven fans, the pressure in the ashpits being 1in. of water. No coal or other fuel was mixed with the refuse, which burnt freely; the maximum temperature observed being 2500 deg. Fah., and the average 1500 deg. Fah. Considerable inconvenience was experienced owing to cold air rushing into flues during clinkering operations, the trouble being to a great extent unavoidable, and called for a perfect system of dampers. The clinker residue amounted to 32 per cent., and was at present difficult to dispose of owing to the cartage from works to the outskirts of the town being high. The clinker was suitable for making mortar-concrete, and, when ground and mixed with Portland cement, made excellent paving slabs. The works were managed on the eight-hour shift system, seven days per week. The feed-water for the boilers was drawn cold from storage tanks by three-throw pumps, which forced it through economisers placed in the main flues, where it was raised to a temperature of about 200 deg. Fah., depending upon the heat of the flue gases and condition of economiser. The water was then forced upwards into a large feed-water storage cylinder, 30ft. by 8ft., fixed about 20ft. above the boilers, and was connected direct to the main steam line, and which was therefore at the same temperature and pressure as the boilers, which were fed directly from this cylinder by gravity, the water flowing into the boilers freely without any strain or racking action on the check valves. The steam generated in the boilers, at an average pressure of 140 lb. per square inch, was disposed of mainly by the engines attached to the electric generators, although a small portion of live steam was supplied for clothes-washing purposes to the public baths and washhouses adjoining the electricity works; exhaust steam was also supplied to the baths and free library, which were entirely heated from the steam raised by the refuse destructor.

The average cost of burning the refuse during the second year of working, including four furnace men, two top men and one charge man, supervision clerks, &c., cleaners and yard men, repairs, stores and sundries, was 2s. 6·9d. per ton. The amount of electric energy absorbed in dealing with the refuse, including electric fans, lifts, trucks, and lighting, was 4·98 Board of Trade units per ton per annum. A number of evaporative tests had been taken, with the result that with one boiler and two refuse furnaces it was possible, by the burning of ordinary refuse, to evaporate 2888 lb. of water per hour, from and at 212 deg. Fah.

The average calorific value of various tests was 0·99 lb. of water per lb. of refuse. The heating surface of each boiler was 1300 square feet; the refuse grate area was 25 square feet, and the coal grate area was 27 square feet. The total amount of energy sold by meter to consumers was 1,031,348 Board of Trade units, including 131,140 units supplied to the refuse destructor. The total amount of refuse burnt was 26,201 tons, and of coal consumed 1344 tons—value £1,308 14s. 8d. The item of cost per ton for interest and redemption of land and plant—not usually considered in connection with refuse destructors—was a matter for serious consideration, and in the case of the Shoreditch destructor plant—where land is very expensive—the charge worked out at practically 1s. per ton.

MEETING OF STUDENTS.

The students of the Institution of Civil Engineers held their second meeting for this session on Friday evening, December 15th. The chair was occupied by Mr. G. R. Strachan, M.I.C.E. A paper on "Sludge," by Mr. Blamey Stevens, Stud. Inst. C.E., was read by Mr. A. D. Creer, Stud. Inst. C.E., in the absence of Mr. Stevens. The following is an abstract of the paper:—

Sludge may be considered as a special kind of mud, made up of water and more dense particles of all sizes and shapes. If the solid matter per unit of volume be represented by $(1 - S)$, and the specific gravity by ρ, while P represents the kinetical coefficient of viscosity, the standard being in each case water at 0 deg. Cent., it is found that, in any series of sludges which differ only in the amount of water they contain, $S \propto P^{-1}$ approximately, when $S > 0$ and the ordinary formulas for the flow of viscous liquids are applicable.

When $S < 0$ the sludge is solid and may be considered as a compound material composed of granular, very elastic, mucous matter and water. The mucous matter by itself settles down to an angle of slope $(\tan^{-1} \alpha)$ of about 20 deg.; but the gravity of the water reduces the angle of repose (θ) to $\theta = \tan^{-1} \frac{\rho - 1}{\rho} \alpha$, and the cohesion of the water further affects this angle.

The methods of converting sludge from a liquid to a solid state, and *vice versâ*, are stated, and the parts played by lime and bacteria in modifying the sludge are pointed out.

In the construction of a pipe line one has to beware of getting too much resistance, or two little power, or in any way inducing stoppage of the pipe.

Tanks should have a slope $\theta = \tan^{-1} \frac{\rho - 1}{\rho} \alpha$ or more, but in every case men have to get into the tanks to push the sludge out. Sludge has generally to be pumped through a comparatively small range of pressure only, and the piston or plunger pumps, air-pressure ejectors and chain or ladder pumps may be made of the same size as for water, but the valves must in general be modified. Centrifugal pumps must be constructed differently from similar pumps for dealing with water; there are no very reliable pumps of this class existing.

For filter presses lime is the only cheap substance which can be used, and its beneficial action is wholly due to the consequent increase of the speed of working the press. For solid sludge the formula $\left(\frac{8}{3}\right)^{14} = p$ (approximately) is applicable, where p is the pressure in metres head of water, so that the high pressures employed in presses only increase the speed of working the press, and if sufficient time is given sludge may be drained on porous ground or rubbish to a very substantial cake.

For solid sludge the required inclination or equivalent fall of head in a channel or pipe is a maximum where or when the motion is started, and is $\tan^{-1} \frac{\rho - 1}{\rho} \alpha \left(1 + \frac{k_1}{m}\right)$ where m the mean hydraulic depth and k_1 the depth below the sludge ace in the water-tight tank in which it has drained.

Sludge may ultimately be disposed of by aëration. It is not yet proved that it has no value for farming purposes, but the highly adulterated state of its manurial constituents reduces its value to some extent.

In burning sludge the temperature 1100 deg. Cent. has to be exceeded; hence we are able to construct a heat equation, showing how much water any particular sludge may contain to burn without nuisance.

A great deal of sludge is now taken to sea in specially constructed tank-boats, and other equally simple methods are gaining ground.

When sludge is immersed in water its activity is increased in the ratio $\frac{\rho - 1}{\rho}$; hence such sludge is very difficult to deal with. It cannot be drawn into a nozzle by suction, because the water, being so much more limpid, rushes past it, and it has consequently to be first dealt with by some kinematical means. Dredging is, however, not indispensable, as directly the contact between the sludge and the overlying water is severed, the former may be easily dealt with.

A simple plan in some cases is to mix the sludge with the overlying water, when the latter is flowing to some more convenient depositing ground.

In conclusion the author introduces some economical considerations.

The Chairman afterwards gave an account of some of his experiences in dealing with sludge.

THE NORTH SYDNEY SEWERAGE SCHEME.

THE following extract from a paper read before the Royal Society of New South Wales by Mr. J. Davis, M. Inst. C.E., Engineer-in-Chief for Sewerage Construction for New South Wales Government, will, we think, be found to possess a good deal of general as apart from local interest.

In the year 1882 the sanitary condition of what was then known as North Shore, East St. Leonards and Victoria, had become so defective that the Minister for Public Works authorised a sewerage scheme being prepared in this department. The late Mr. W. C. Bennett, M. Inst. C.E., who was Engineer-in-Chief for Sewerage at that time, instructed Mr. Bowyer-Smijth, M. Inst. C.E., to prepare a comprehensive report on the question. The area under consideration being hilly, sloping to the shores of Long Bay of Middle Harbour on the north, and Sydney Harbour on the south, has ideal facilities for drainage by gravitation sewers to one or the other of its tidal frontages. Mr. Bower-Smijth recommended that provision should be made for collecting and conveying the sewage by gravitation through the hill between Sydney Harbour and Long Bay, to disposal works at the latter place. The total area provided for in this proposal was 350 acres; the length of sewers contemplated 9½ miles, and the cost was estimated would be £60,000. It was suggested that the sewage should be precipitated and filtered before being discharged into the waters of Middle Harbour.

The surroundings of North Sydney are such that a sufficient area of suitable land could not be found for broad irrigation within any reasonable distance, and to purify the sewage before discharging it into the tidal waters, it was decided that no more satisfactory method than precipitation and intermittent filtration could be adopted. For this purpose it is certain that a better site could not have been chosen, for while not so remote as to entail an expensive length of outfall sewer, the immediate surroundings are so precipitous that the neighbourhood of many buildings is a remote possibility. Moreover, the is every facility for allowing the sewage to gravitate in every step of its treatment through the tanks to the effluent outlet, thus saving the expense entailed in many similar works of pumping. The question, however, was allowed to remain in abeyance until 1886, when the pressing necessity for immediate action again appears to have asserted itself upon the authorities. By this time, although only four years had elapsed, the population has doubled itself. At the end of the year, at the instance of Mr. Bennett, a comprehensive and independent investigation was made by Mr. G. H. Stayton, M. Inst. C.E., of the sewerage department, and on the data collected a scheme of sewerage was submitted by that gentleman. This scheme, though differing in extent and detail from the original proposal, embodied the same principles. At the suggestion of the Engineer-in-Chief for sewerage, the Secretary for Public Works moved Parliament to submit this amended scheme to the Parliamentary Standing Committee on Public Works. The evidence taken by the Committee resulted in the recommendation to Parliament that the scheme be carried out by the Government.

The drainage area of the amended proposal was 888 acres, with an existing population of 12,000, and an ultimate maximum population of 30,225. Mr. Stayton proposed that the sewers should be calculated to discharge the following:—Sewage or dry-weather flow, 50 gallons per head per day; rainfall, 40 per cent. of 1½in. during 24 hours, or 1·26 cubic feet per minute per acre, half the daily sewage flow to pass off in four hours. The amended scheme included twenty-four miles of main, sub-main, and subsidiary sewers. The growth of the locality has been so rapid, however, that it has been found necessary to extend the scope of the system to the adjoining suburbs of South Willoughby and Mosmans, and the outfall works are now designed to treat the sewage from an area of 2328 acres, divided as follows: North Sydney, 608 acres; Mosman, north, 720 do.; Mosman, south, 727 do.; South Willoughby, 273 do.; total, 2328 acres. The altered circumstances permitted the discharge of the sewers to be calculated on the following basis:—

Sewage flow.. ..	·57	cubic feet	per	min.	per acre.	
Rainfall allowance	1·26	,,	,,	,,	,,	N. Sydney
,, ,,	·63	,,	,,	,,	,,	N. Mosman
						S. Willoughby
,, ,,	·94	,,	,,	,,	,,	S. Mosman

half the daily sewage flowing off in six hours. The present flow treated at the outfall is about 750,000 gallons per day.

Description of sewers.—The scheme was practically initiated in 1891 by the construction of the main outfall sewer from Milson's Point to Willoughby Bay. This is the principal artery of the system, and has a length of nearly two miles, its highest level at Milson's Point being 40ft., and its outlet 19½ft. above the datum, which latter is 1·125ft. above mean high water. The sewer is oval in section, built in on concrete with brick arching round the upper half, and ranges from 4ft. 6in. by 3ft. 6in. to 3ft. 3in. by 2ft. 2in. The grades vary from 1 in 540 to 1 in 750. The level at the outlet is kept high enough above high water to allow of the sewage passing through its various stages of treatment by gravitation before being discharged into the harbour. Passing under the high land along Alfred-street the tunnel in places is 260ft. deep. The sub-mains, however, are at a lesser depth, their contents reaching the main sewer through drop pipes built in the sides of segmental shafts as shown on the attached drawing. There are twelve of deep shafts shown on the main line, substantially built of brick and concrete, which are provided with wrought iron ladders and all appliances necessary to facilitate inspection, flushing, and ventilation.

The sub-mains are either brick-and-concrete oval sewers or stone-ware pipes, varied with the requirements of the area drained. The chief sub-mains in North Sydney are those from Blue's Point and Lavender Bay, and, like the main sewers, these are oval sewers in tunnel through rock. To intercept the drainage of the southern half of Mosman, a branch sewer, 185½ chains long, is now in course of construction. It will rise near Little Sirius Cove, and after traversing the harbour slopes as an oviform sewer in tunnel, finally discharges into the main sewer in Alfred-street. On this sewer a length of 85 chains will be built of pipes constructed on the Monier system. The principle of this system of construction is to increase the strength of structures by the judicious insertion of iron rods in cement, the effect is to admit of lightness and economical proportion in arches, floors, or other works, as the case may be. On the Mosman sewer, oval pipes 3ft. 1in. in length, and of 2ft. 6in. by 1ft. 9in. cross sectional dimensions are to be built on this principle; a lattice of wrought iron is inserted in the cement of which the pipes are formed. The joint is effected by running neat cement into grooves round each end, and so forming a dowel or tongue.

Under some circumstances the cheapness and speed with which such work can be done, renders a great saving of money and time possible, as against the ordinary brick-and-concrete sewer. In the South Mosman branch the discharging capacity of the sewer did not require it to be over 2ft. 6in. by 1ft. 9in., and the Monier construction enabled the sewer to be built that size; whereas if the ordinary section had been adopted—concrete and brickwork—the smallest size which could be constructed with advantage is 3ft. 3in. by 2ft. 2in.

A steel arch will carry the sewer in the form of a riveted steel tube over the head of Mosman's Bay, and other aqueducts are to be built where depressions have to be crossed. Another branch sewer, the first section of which tenders will be called for in the course of a few weeks, will be constructed to drain the Northern or Middle Harbour side of Mosman. This will join the main sewer near its outfall. The South Willoughby branch, 70 chains in length, is now being constructed, and, like the Mosman branch, will be an oval sewer in tunnel through rock. Here also a "Monier" pipe 2ft. 6in. by 1ft. 9in. is being used, and the remarks made as to the South Mosman branch apply in this case. The work of reticulation, which has in the main been constructed by the Water and Sewerage Board, has now been finished over a portion of North Sydney, and a large population is already served by the system in that borough. With the completion of the branches to the other suburbs, the whole of the area will be similarly connected.

Method of sewage treatment.—The original method and site of sewage disposal has been practically adhered to, and briefly, the process in operation is as follows. After the sewage has passed through screens, to remove the larger floating solids, which are afterwards burnt, it is treated with lime to facilitate precipitation of the suspended matters in the settling tanks. After settlement has taken place, the clearer top liquid flows over a weir situated at and forming the end of the tanks into an effluent channel, which conveys it to filter beds, where it is purified by oxidation and bacterial agencies, and eventually finds its way to the tidal waters as a harmless effluent. The solids, on the other hand, are deposited as sludge in the tanks, which is drawn off and reduced to sludge cake by forcing the liquid sludge through filter presses, and the cake then burnt in destructor furnaces. Adjoining the outlet of sewer and the building are five large settling tanks built of concrete with brick lining, of such an aggregate capacity that four will cope with the average daily sewage flow for many years to come, leaving the fifth as a reserve for an emergency.

Abutting on the settling tanks, and so placed as to receive the deposited solids from them when required, is a sludge reservoir, which is a long covered concrete chamber of about 8100 cubic feet capacity. An open conduit of concrete, superposed on the sludge reservoir, conveys the sewage to the tanks from the straining chamber in the building. The open effluent channel, also of concrete, conveying the effluent floated off from the tanks, runs round two sides of the latter, and then passes along the sides of the filter beds, distributing its effluent through offlet valves and troughing over each bed as required. Willoughby Falls Creek formerly discharged into the head of the bay, and when this was filled in for the filter beds, it was necessary to build a storm-water channel to conduct the stream through the reclamation to the tidal waters. This channel is also available as an overflow for the main sewage conduit near the tanks, and relieves the works of any exceptional flow of storm-water during continuous heavy weather. The filter beds are protected on the harbour frontage by a rubble dyke, and a jetty has been provided for the purpose of the works. Two contracts were let for the construction of the outfall works. One included the preparation of the site for the treatment works, and the formation of the filtering areas and the construction of storm-water and effluent channels. The second contract comprised the erection of the tanks and buildings, as well as the supply and installation of the air-compressing machinery and fittings. The air-compressing plant consists of a Tangye horizontal steam engine, Type H, which drives a horizonal double-acting air compressor. The air-compressing cylinder is 11in. diameter and 18in. stroke, with water jacket and all necessary fittings. The inlet valves are opened and the outlet valves closed automatically.

Process of treatment.—The sewage upon reaching the treatment works first passes through the screening chambers, which are in duplicate. The screens are of wrought iron bars, and can be lifted alternately and cleaned of the floating solids retained. These are burnt in the destructors. The sewage after screening flows along a winding channel, where a concentrated solution of lime prepared in a mixer in the adjoining room is admitted into the stream. The supply of lime can be regulated according to the flow of sewage. The quantity to be used, which is at the rate of one ton for every 1,000,000 gallons of sewage, is shown by a dial indicating the flow of sewage passing into the works from the main sewer. This contrivance is worked by a float in the sewer near the works, and while indicating the number of gallons flowing, at the same time draws a diagram recording the flow each twenty-four hours.

The sewage next passes through a cast iron rotary agitator or churn embedded in the conduit, and the lime is thereby thoroughly incorporated with the sewage. The agitator and lime mixer are driven by shafting and belting from the engine in the basement adjoining. The sewage passes from the agitator into an open concrete channel 5ft. 3in. by 3ft. 3in., which runs along the whole extent of one side of the five settling tanks at a higher level than the latter. There is an offlet pipe from the conduit into each of the tanks, so that by opening the valves attached the sewage may be admitted into any of the tanks as required. Each settling tank has a capacity of 93,750 gallons. All of them are so arranged that one or more can be used continuously, or each may be filled, allowed to rest, and emptied in rotation. It is preferable generally to adopt what is called the "continuous-flow" system, that is, two or more tanks are used continuously at one time. The present maximum dry-weather flow, 750,000 gallons, can be treated in this way by two tanks, the liquid at the surface being floated off continuously over a weir at the end of the tanks. Even during the six hours of maximum flow each day the capacity of two tanks is such that they would be emptied twice only in that time, or once every three hours, a rate quite sufficient to allow of complete precipitation of the grosser solids. Of course during the time of lesser flow, or eighteen hours of the day, one tank would be ample for the present discharge, as it would take four and a-half hours for the sewage to pass through it.

Four tanks working together in this way would be able to cope with the greatest daily flow for many years to come. Ultimately,

however, when the maximum population realised, additional tanks will have to be provided, and for these ample space has been left. When after a few days the tank becomes foul, it is necessary to empty it into the effluent channel. To ensure that in this process only the liquid portion of the contents of the tanks is removed, a floating arm controlled by a valve has been adopted. The liquid sludge which remains in the tank passes down the dished and sloped bottom by gravitation, into the sludge reservoir adjoining. The sludge is allowed to gravitate from the reservoir through a 12in. pipe into two close-riveted steel cylinders each of 900 gallons capacity, which are situated immediately under the presses. Lime is again supplied in a suitable proportion, to facilitate the pressing of the cake. Near the sludge receivers, and of similar construction and capacity, is a third cylinder for compressed air, which is supplied from the air compressor at a pressure which for all ordinary requirements averages about 80 lb. per square inch. When the sludge receiver is filled the sludge supply pipe is closed, and an inlet valve from the air cylinder is opened. The compressed air exerts a steady downward pressure on the surface of the sludge, forcing it through a dip pipe which passes up to one or other of the filter presses on the upper floor of the building. The filter presses were manufactured by Messrs. Manlove, Alliott, and Co., of Nottingham, and specially designed for these works. Each press consists of a series of rectangular cast iron plates, each 3ft. 2in. square, vertically hanging between and bearing upon the sides of a strong frame in such a way that they can be moved together or apart. Each plate is cast with a 4in. diameter hole in the centre. At one end of the frame a strong cast iron cylinder is attached, into which compressed air can be admitted, with the effect of actuating the headstock that bears against the series of plates. To prepare the plates for use each is tightly sewn up in filter cloth, leaving the hole in the centre open.

A small quantity of slack coal is used to start the combustion in the destructors. After a fair start, owing to the greasy nature of the cake—with the coke breeze mixed with it after leaving the press—it burns quite freely, producing a hard clinker quite devoid of the slighest odour. The amount of sludge produced by precipitation with the present population, would, if the area were all sewered, be about 15 tons a day. At present, however, the quantity is not more than three or four tons. This amount is greatly reduced by pressing; five tons of wet sludge from the tanks producing only one ton of sludge cake, the difference represents the liquid portion which is extracted by the presses. Fully 90 per cent. of bulk of the wet sludge is water, but the percentage in the cake after pressing is only 55. The value of the cake as manure is naturally not as well known or appreciated as in countries where intense cultivation is practised, and it was deemed inadvisable to rely solely for any demand for the product, as a means of disposal. On the other hand burning was a method readily available, and after all the most efficacious. After the sewage has passed through the filter beds it is collected in its purified state by the underdrains, which are of perforated pipes laid in coke breeze. These converge into an outfall pipe 21in. diameter, which discharges into Willoughby Bay slightly above mean spring tide level. When drain pipes in sand filters have been made sufficiently porous to admit of the effluent passing freely into them, difficulty has been experienced in keeping the sand out. As the success of the filter beds depended upon both the effluent getting into the pipes and the sand being kept out, before finally deciding the mode to be adopted at Willoughby Bay it was deemed advisable to carry out experiments. Three tanks were constructed, each 4ft. deep, and having a combined area of 0·9 of a yard. At the bottom of each tank a glazed perforated pipe was placed and surrounded with 6in. of fine breeze coke, the perforations being $\frac{1}{16}$in., $\frac{1}{8}$in., and $\frac{1}{4}$in. diameter respectively. The boxes were then filled with sand to within a few inches of the top. Each tank formed a miniature sand filter, and as no sewage was available the city water was laid on to them.

The water, which was measured by meter, was turned on at 3.30 p.m. on Friday, 10.h December, 1897, and at 11.12 a.m. on Saturday the meter recorded 2245 gallons as having been used. The rate of flow would therefore be 120 gallons per square yard per hour, or, say, 13,939,200 gallons per acre, when it was found a very small quantity of sand passed through the coke into the pipes. The $\frac{1}{16}$in. and the $\frac{1}{8}$in. had given slightly the best result. The experiments were continued to 28th December, 1897, and quantities varying at the rate of from 4,250,000 gallons per acre per day, to 14,907,200 gallons, when practically no sand was carried into the pipes. As, therefore, not more than one-tenth of the smaller quantity, 4,250,000 gallons per acre per day would ever be put into the filter beds at Willoughby, it was, the author thinks, safely assumed that (*a*) the perforations and coke surrounding the pipes would permit of the effluent entering the pipes faster than required; and (*b*) that with the maximum flow of sewage at the rate of, say, 400,000 gallons per acre per day no sand would be carried into the effluent pipe. The author finally decided to adopt the $\frac{1}{8}$in. perforations, as no more sand passed through these than the $\frac{1}{4}$in. perforations. It is also thought that the presence of the coke round the pipes will have the effect of preventing the growth of fungus in the perforations. The principles which underlie the purification of sewage by intermittent downward filtration need no justification on the part of the author. The highest scientific and practical evidence has firmly established the efficiency of this method, based as it is on natural processes. It is only, therefore, necessary to mention that in the North Shore Works the main features of the most modern system of filtration have been adopted.

Each filter bed is in reality a bacterial hot bed, where, through chemical changes brought about by micro-organisms, the organic impurities of the sewage, which constitutes its chief danger, are broken up into harmless forms. It must be remembered that about two-thirds of the suspended solids, organic and otherwise, are left behind as sludge in the settling tanks.

The surface of the filter beds retain most of the remainder, and thus the first function of the bed is to some extent a mechanical one, but it is the organic matter in solution, and the finer particles in suspension particularly which are chemically and biologically dealt with and rendered innocuous in the filter bed. The sewage as it sinks through the sand clings as a thin film over every particle, exposing an enormous surface to oxidation. Air is drawn into the beds during each period of aëration by the sinking of the sewage itself, and by that means the action of the nitrifying micro-organisms facilitated.

Sand, though not primarily as rich in such organisms as a good garden soil, soon becomes an excellent filter capable of cleansing the sewage, which has previously been subjected to precipitation, of as many as 8000 persons per acre, if intermittently applied and the beds sufficiently rested. On that basis the present filtration area, eight acres, will provide for a maximum population of over 60,000 persons. With the supply, therefore, regulated and equalised by means of the tanks, there is no doubt that the present filtration area will suffice for many years to come. By the time the drainage area served attains its maximum prospective population, say 80,000, an extension of the treatment works will become necessary. There would be no difficulty in this, but it may be presumed, in view of the rapid strides which are being made in the treatment of sewage by filtration, that it can be effected without increasing the filtration area. The works at Willoughby Bay admit of any such later modifications, but, as before stated, for a very long time to come the methods in operation will be ample and efficient. The treatment works having only recently been put into operation, there has hardly been time to procure an analysis of the effluent, but it is hoped one will be available for the information of the Section at the next monthly meeting.

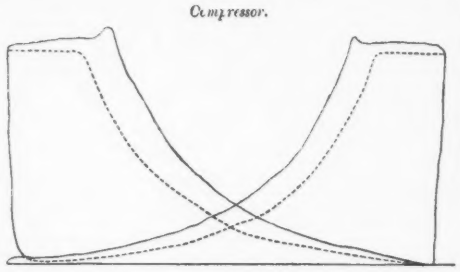
Test of efficiency of plant.—On June 6th and 7th, 1899, tests were made of the machinery. On the first day the boiler only was being fired, and half a ton of slack coal was consumed in ten hours. During this time the sludge presses were running, and the engine, therefore, was driving the compressor and lime and sewage mixer. On the second test, again for a period of ten hours, the boiler and one destructor furnace were being fired, consuming together three-quarters of a ton of slack coal. The sludge presses were also in operation, and the engine was driving the compressor and lime and sewage mixers. The coal used for each day included that used for lighting up. The extra coal used on the second day was required to start the destructor furnace. Indicator diagrams were taken of the compressor and engine under varying conditions, viz:—(1) Full load driving compressor and lime mixer. (2) Light load, engine driving lime mixers and shafting only. In each case a constant pressure of 80 lb. per square inch was maintained in the receiver, and a steam pressure of 80 lb. per square inch on the boiler.

North Sydney Outfall Works.

Engine—	
Mean total I.H.P.	22·5
Diameter of cylinder in inches	10
Stroke in inches	20
Diameter of piston-rod in inches	1¼
Revolutions per minute	115
Boiler pressure	80
Compressor—	
Mean total I.H.P.	15
Diameter of cylinder in inches	11
Stroke in inches	18
Diameter of piston-rod in inches	1¼
Revolutions per minute	50
Efficiency	73·1 per cent.

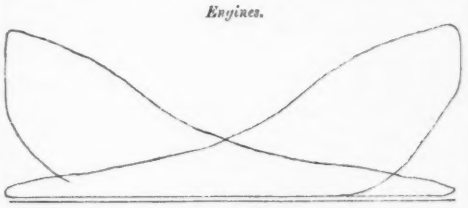
NOTE.—2 I.H.P. to be deducted from engine for lime and sewage mixers. The rise at the top of compression curve is caused by the inertia of the outlet valves in opening. If the temperature in receiver fell to atmospheric temperature, the efficiency of air compressor would by 56·22 per cent.

Compressor.



	Back.	Front.
Area	1·75	1·9
M.E.P.	24·3	26·3

Engines.



	Back.	Front.
Area	2·55	2·25
M.E.P.	37·5	34·02

Scale 50. Taken at full load, June 7th, 1899.

NOTES FROM JAPAN.

(*By our Special Correspondent.*)

ALTHOUGH the ink is scarcely dry on the last "Notes" which I sent you, I have the melancholy task of chronicling the death of two of the oldest and most respected members of our profession among the foreign community in Japan. Although I have had the pleasure of their personal acquaintance and friendship for some ten years past, I am indebted to elder residents and other sources for their earlier history. Mr. Archibald F. Macnab came out here some thirty years ago as a marine engineer in the employment of the Peninsular and Oriental Company, having passed his earlier years in Russia. He was subsequently for many years in the employment of the Japanese Government, first in the Lighthouse Department and afterwards in the Marine Bureau, but has lately acted as one of Lloyd's surveyors. He was a member of the Institution of Civil Engineers since 1864, and in recognition of his services to the Japanese Government had received the decoration of the Third Order of the Rising Sun. The Marine Bureau, after the Japanese custom, sent a pair of beautiful floral standards to the funeral, which was attended by almost every foreign resident in Tokyo, a large number from Yokohama, and numerous of his Japanese friends. He leaves a widow and one son. He died on 27th October, in his sixty-first year.

Mr. Alexander Macmillan, who died on 2nd November, aged forty-eight, had been for many years Chief Foreign Superintendent of the Nippon Yusen Kaisha—Japan Steamship Company—the largest and most important steamship company in the East, to which numerous references will be found in your columns, and to the success of which his untiring exertions and sterling business capacities had materially contributed. His health had been considerably impaired by a sunstroke some five or six years ago, and by a serious fall which fractured two of his ribs in December, 1897, but although he had more than once tendered his resignation, the directors were unwilling to accept it, and a somewhat prolonged holiday had apparently restored his health to a certain extent. The death of his old friend Mr. Macnab was a great shock to him. As he had received from the Japanese Government the Third Order of the Sacred Treasure, the funeral should have been escorted to the grave by a detachment of troops; but for this three days' formal notice must have been given, and his widow and friends preferred a more private ceremony. Nevertheless the directors and officials of the Nippon Yusen Kaisha, and of the Mitsu Bishi Company, with which he had been previously connected, sent ninety-six beautiful stands of flowers, not to mention the numerous wreaths and floral decorations sent by his private friends. Mr. Macmillan, who served his time as an engineering pupil with Denny and Co., of Dumbarton, came out to Japan about twenty-five years since.

It is a melancholy coincidence that the last three deaths which have occurred among the foreign community of Tokyo should have been those of engineers, all three, moreover, being Scotchmen. The third one was Professor William Kinninmond Burton, son of the late Historiographer-Royal for Scotland, which occurred on August 5th last, from a complication of diseases supervening upon Formosan fever. After serving his time with Brown Brothers and Co., of the Rosebank Works, Edinburgh, and filling one or two minor appointments, he was occupied for some time in sanitary engineering in London, in connection with the late Cosmo Innes, and was engaged about fifteen years since by the Japanese Government as Professor of Sanitary Engineering in the Imperial University, Tokyo, where he did some splendid work. For some years he was adviser to the Tokyo municipal authorities in connection with the water supply of the city; but finding his advice persistently ignored, he resigned the post. Latterly he was exclusively employed by the Department of Agriculture and Commerce, chiefly in connection with the water supply and sanitary improvements of some of the most important towns in Formosa, and while so engaged he contracted a severe attack of Formosan fever, from the effects of which he never entirely recovered, although until a day or two previously his death was entirely unexpected even by his most intimate friends. He was an untiring worker, and the author of a standard work on waterworks and water supply, which was favourably reviewed in your columns a few years since. The manuscript of another work on similar subjects was lost in the wreck of the ill-fated steamer Aden, and unfortunately he had kept no copy. In the field of photography he had a world-wide reputation, and his manual for the use of beginners has probably been more popular and widely known than any similar publication. It will be long before the gap in our professional and social circles caused by the loss of these three friends will be obliterated.

A new industry.—Messrs. Seiko Okuda and Ryoken Tsurumi, two gentlemen of Nagoya, are about to commence the manufacture of *tsumugi ito*, or pongee yarn. The buildings are already completed, and the machinery is now being fixed. It is hoped that everything will be ready by the end of the year. The number of spindles is stated at 22,800, and employment will be furnished to upwards of 300 hands.

Plumbers.—The recent extension of the gasworks and the approaching completion of the waterworks in Tokyo have brought about a demand, at present much in excess of the supply, for skilful plumbers to carry out the connections from the mains. This want was foreseen years since by the late Professor Burton. At that time an exceptionally skilful working plumber was in the employment of first one and then another Government Department, and Professor Burton strongly advocated the desirability of engaging him as a practical demonstrator to be attached to the mechanical laboratory of the University, or to one of the technical schools which were then being inaugurated; but the opportunity was lost. Now, some years too late, the apprentice school attached to the Tokyo Technical School is making arrangements for the training of a large number of "artists in lead." The principal of the apprentice school is confident that a three months' course for pupils who have completed the ordinary courses of an elementary school, or six months at most for raw boys, will be sufficient to convert them into efficient, not to say expert, plumbers. But as every man or boy who has learnt enough of the noble art to be able to "wipe a joint" can get immediate employment at very comfortable wages, it is difficult to see where the practical instructors are to come from, and it is scarcely a craft which can be taught by a professor with a stick of chalk and a black-board. There will probably be some "revelations" when the water is turned on. The last report is that there is only one student in the plumbing course of the apprentice school. Statistics as to the number of teachers have not been published. But, lest my remarks may be misunderstood, I would strongly advise any competent—and still more strongly any incompetent—plumber not to throw up even a bare pittance in England for the chance of picking up a job in Japan. No foreign mechanic, unless specially engaged under a hard-and-fast agreement, has a chance of making even a bare living out here, and he would probably have to send the hat round, as soon as he had exhausted the funds in his pocket, for money to pay his return fare.

Government contracts.—The results of two important tenders have recently been published, as follows: 2570 tons of 60 lb. rails and fastenings, and 100 tons rolled joists for bridges, for the Taiwan Railway, Formosa:—

	£
Mitsui and Co.	26,298
Jardine, Matheson, and Co.	27,457
Yokoyama	28,142

To be delivered in Formosa before June 30th, 1900.—21,526 tons of 60 lb. rails and fastenings, for the Government Railways, Japan:—

	£
Mitsui and Co.	178,217
Takata and Co.	193,681
American Trading Company	196,744
China and Japan Trading Company	206,426

Thirty per cent. of the total quantity to be delivered in Japan before May 31st, 1900, and the balance before September 30th, 1900.

In each case Mitsui and Co. are supposed to have offered on behalf of the Carnegie Steel Company, Limited. The unsuccessful competitors did not disclose the names of the makers whom they represented. In the first case import duty was included in the price, but not in the second case.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE question of coal supply was a very important item at to-day's—Thursday's—Birmingham market. The coal famine, though not yet quite so acute as in South Yorkshire, is making itself felt here, and the ironworks in some parts of the district are a good deal inconvenienced as the result. Coalowners complain that they cannot get the railway companies to move the stuff from the pits, and the railway traffic managers' only reply is that they can neither get trucks, nor yet facility for moving them out of the sidings when loaded. The mineral now being brought to the surface has often to stand for days, or even to go into stock, before it can be consigned to the consumers. This difficulty of getting fuel at the ironworks accounts for much of the delay in the current execution of orders at the mills and forges, and keeps iron prices for anything like early delivery at a premium. Nor is there likely to be much relief in the new year. This last is the most serious part of the business. It is believed that, with their present rolling stock and crowded state of main lines, the railway companies will continue to be utterly unable to deal adequately with the traffic.

In the iron branch both finished and raw orders were more abundant than producers were able to accept, and the fullest confidence was expressed in New Year prospects. One effect of the war is the placing of some large orders in the district for railway spikes for South Africa, and iron for the purpose has been bought, and a premium price given for urgent delivery. Most strength appeared this afternoon in the finished iron department. Prices were very firm, and the unmarked bar makers would not accept any new forward contracts except at 10s. per ton advance, making the standard £10 per ton. It was understood that marked bars remained at £10 10s., with £11 2s. 6d. as the Earl of Dudley's price. This is the highest price prevalent since 1874. Hoops are quoted £10 10s., and nail rods £9 15s. to £10 per ton.

The sheet iron trade fully sustains the recent improvement which has marked this branch. The demand from the galvanisers is larger than it has been for a long time, and inquiries are still coming forward with much vigour for the export markets, not excepting even South Africa. Prices are firm on the basis of £10 10s. to £10 12s. 6d. for 20 w.g., £10 12s. 6d. to £10 15s. for 24 g., and £11 5s. to £11 7s. 6d. for 27 g. Galvanised corrugated sheets are £15 f.o.b. at outports. The Australasian mail brings news that at Dunedin galvanised sheets at date are fetching £22 10s. per ton, while at Wellington there is a large demand at £21 and £21 10s. for best brands and £20 for second grade brands. Fencing wire is commanding £11 to £11 10s.

In the pig iron department prices show continued strength, with every prospect that higher rates will be asked in January and February. The contracts for pig metal usually arranged at this time of the quarter are on this occasion being largely deferred until the prospects of coal and coke prices are better understood. Pig iron sellers in this district refuse to be dominated by the Scotch and Middlesbrough lead, declaring that the decline in the North is entirely due to the speculative element. Sales on this exchange are mostly for absolute consumption, and concern them-

selves mainly with Midland and Staffordshire brands, very little Scotch or Cleveland iron finding a market locally. To-day (Thursday) prices were well preserved on the following basis:—Staffordshire cinder forge, 70s. to 72s. 6d., with a few makers quoting as high as 75s.; part mine, 75s. to 77s. 6d.; all mine, 77s. 6d. to 82s. 6d.; best ditto, 90s. to 92s. 6d.; and cold blast, 120s. to 125s., and in some extreme cases, 27s. 6d. per ton. Northampton forge pig iron was quoted 73s. to 75s.; Derbyshires, 74s. to 76s.; and North Staffordshire, 76s. to 78s. per ton. Foundry pig iron is specially dear, the average price of hot blast South Staffordshire qualities being 85s.

The urgent call for steel is unabated, and all the works have more orders than they can execute. The demand, indeed, is quite beyond makers' means of output. Under these circumstances prices are still advancing, and current open market quotations may be named as:—Bessemer billets and blooms, £7 5s. to £7 10s.; best Siemens ditto, £7 10s. to £7 15s.; mild bars, £8 15s. to £9; constructive engineering plates, £9 5s. to £9 10s.; and girders and channels, £8 15s. to £9 per ton.

Constructive engineers throughout the Birmingham and South Staffordshire district continue extremely active, and are working night and day in an effort to overtake orders. This, however, is impossible; many firms have sufficient work booked to keep them fully engaged throughout the whole of 1900. The pipe founders are busier than for years past, and one firm has during the week added to its books a Birmingham Corporation contract representing some £3500. Large-sized pipes are required. Hot-water and heating engineers are doing well, and the boiler yards are full of work, and are likely to be well into 1901 or 1902, judging from present outlook.

The South Staffordshire and East Worcestershire Coal Trade Wages Board met at Dudley a few days back, and the coalowners granted the men a further increase of 5 per cent. in wages to take effect from January 1st. This will bring wages up to the maximum agreed upon by the National Federation for next year.

The re-opening of the important Hamstead Colliery in the West Bromwich district, which was shut down owing to fire many months ago, is now nearly accomplished. The ten-yard coal has now been driven into, and the active driving of the coal roads in the old workings will be almost immediately in progress. It is hoped that in three months' time the greater part of the workmen will be back again in their old places.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The general unsatisfactory tendency of the iron market here, to which I referred last week, has since become still more noticeable, and the close of the year threatens to be anything but hopeful as to the immediate future. The further considerable drop in warrants has quite unsettled business, much to the advantage of "bear" speculators, and where transactions are just now being put through—which are mostly only in small quantities—they are at prices cut so low that makers are practically altogether out of the market. The increasing seriousness of the situation in South Africa and the disturbed financial position, both at home and abroad, are no doubt the main factors in bringing about the present depression. Certainly, as I pointed out in my previous notes, there has been no change in the situation as regards legitimate requirements for actual consumption to justify any material downward move in prices, and the general conviction amongst makers is that a recovery of the market is inevitable, and, being mostly heavily sold for some time ahead, they are content to wait rather than attempt any competition with speculative dealers for such business as is just now to be secured.

A weak, unsettled market, with only a moderate attendance, characterised the iron 'Change meeting on Tuesday. This was specially noticeable with regard to pig iron, for which there was only a small inquiry, and the business doing was mostly passing through the hands of merchants and dealers prepared to take shillings below what makers were quoting, whilst apart even from the wide margin between makers' quoted rates and the figures dealers would accept, there was a difference of quite 2s. per ton between the prices that low sellers in the open market were asking. For Lancashire foundry brands of pig iron makers were firm at 79s. 6d., less 2½, delivered Manchester. Linconshire makers, perhaps, here and there showed some easing down from their special prices, but 75s. 6d. net would be the minimum figure, with Derbyshire brands still quoted about 78s. 6d. net, delivered Manchester. Forge qualities continue strong, owing to the pressing requirements of Lancashire finished ironworks, and were not quoted under 76s. 3d., 75s. 2d. net for Lincolnshire, and 76s. 6d. to 77s., less 2½, for local brands, delivered Warrington. For both Middlesbrough and Scotch iron prices have been irregular. Ordinary G.M.B. Middlesbrough has been sold as low as 74s. 10d., with some sellers quoting 76s. 4d., and makers asking 78s. 4d. net by rail Manchester. For Eglinton and Glengarnock sellers have been prepared to take as low as 81s. to 82s., Manchester docks.

In the finished iron trade an exceedingly strong tone still prevails, and Lancashire bar makers, although at present booking only very small quantities, are declining to entertain new business except at an advance on the basis rates, which remain at £9 10s., with North Staffordshire bars now advanced to £10, delivered here. Other descriptions of manufactured iron are in fairly active request, with prices firm at late lates.

The position in the steel trade presents no specially new feature. For hematites makers hold to 90s. 6d. to 93s., less 2½, delivered here, although these are many shillings above the present price of warrants. Billets are firm at the recent advance, on the basis of £7 10s. net cash. Bars range from £9 to £9 15s., according to quality; tank plates, £9 2s. 6d. to £9 5s.; and boiler plates quoted £9 10s. to £9 15s., delivered Manchester district.

In manufactured metal goods there has been a reduction of ¼d. per pound in brass wire and brass sheets, but other descriptions remain unchanged.

The reports I continue to receive from representatives of the principal engineering firms throughout Lancashire show no real change in the position generally, activity being well maintained in all the principal departments, and the monthly returns of the Amalgamated Society of Engineers issued this week show a less unemployed list than has been recorded for nine years past, the total number on benefit being 1781 out of a membership of 85,121, or only a little over 2 per cent.; whilst in the Manchester district there are less than 2 per cent. signing the vacant book. The officials report that overtime is still being largely resorted to, but the District Committee has opened up negotiations with the employers for the abolition of overtime on Monday nights. During the month, concessions of increased wages and reduced hours have been secured by the men in several districts.

The monthly journal of the Amalgamated Society of Engineers also contains an obituary notice of the late Mr. William Brereton, the late assistant general secretary, who had filled the position of assistant secretary for about ten years, and in the notice of his career it is stated that "he knew more, probably, of the inner working and history of the society than any man now living, having been a *confrère* of Newton and Allen, of Burnett and Austin." It is also announced that nominations for the filling of the vacancy in the general office caused by Mr. Brereton's death must be sent in not later than January 10th.

The Ardwick Engineering Company has brought out one or two new designs in their special engines for motor car, launch, and yacht requirements. Amongst these, a quadruple-expansion engine, suitable for launches and motor cars, which has cylinders 2in., 2¾in., 3¾in., and 5in. diameter, and 4in. stroke, fixed on four wrought iron columns stayed by means of the crosshead guides. The air, circulating, and feed pumps are worked direct from the crossheads. Another special design is a compound surface condensing yacht engine, with cylinders 3⅜in. by 5½in. in bore, and 6in. stroke, resting on a base fixed to strong standards, on which the guides are cast.

A somewhat excited tone has come over the coal market here during the past week, and for all descriptions of fuel there has been quite a rush of orders. This exceptional pressure has no doubt in large measure been due to the anxiety of consumers to get in extra quantities in anticipation of the usual holiday stoppages of the pits, but the sensational statements that have been appearing in the public press as to the probability of an approaching coal famine have also tended to induce an eagerness amongst users to get in larger quantities than usual, whilst the situation has been rendered still more difficult by the inefficient manner in which the railway companies are just now dealing with the traffic, complaints as to the serious delays in delivery being general.

For all manufacturing classes of fuel the pressure of orders is far in excess of what collieries can meet, and all sorts of special prices are just now being quoted in the market, where buyers are stipulating for prompt deliveries, the list rates that have been quoted recently being for the present little more than nominal. Ordinary steam and forge coals are fetching from 10s. 6d. to 11s. at the pit, whilst for engine fuel 9s. 6d. to 10s. is being got without difficulty before the close of the year, whilst on forward contracts advances of 10d. to 1s. 3d. on current rates are generally being quoted. In house coals also a very brisk demand has been coming forward. Collieries, in fact, have been quite unable to keep up deliveries, and prices are exceedingly firm at the maximum list rates.

For shipment there has been an active inquiry during the past week, and higher prices have been got for anything like prompt delivery, steam coals fetching 12s. 6d. to 13s. delivered at the ports on the Mersey.

The probability of some further upward move in prices with the close of the month continues to be talked of in the market, and no doubt this has had an additional effect in bringing forward an extra demand, but it seems more than doubtful whether the Lancashire coalowners will really decide upon any further yearly advance beyond possibly putting up prices for engine fuel where they did not at the commencement of the month follow to the full extent the advance that was made in the West Lancashire districts. One consideration that is no doubt largely influencing colliery owners in not unduly forcing up prices is, that such a course of action might possibly have the effect of unsettling the minds of the colliers, and thus jeopardising a definite acceptance of the amicable arrangements that have already been conditionally agreed upon, and are at present being put before the men in the various districts. An indication of the possible attitude the men may take up on this matter has been afforded by their unanimous decision in one of the mining districts in the neighbourhood of Manchester, to decline a continuance of the Conciliation Board under the conditions which their representatives had agreed to with the Coalowners' Association; but whether such meetings as the above will really affect the ultimate decision is possibly doubtful.

In the coke trade current list rates, in anticipation of the meeting of the makers' association next week, when it is certain the list basis will be raised at least 2s. per ton, have been generally withdrawn, and, where contracts are asked for, prices about 2s. to 2s. 6d. over present rates are as a rule being quoted, whilst even where these advanced rates are asked, makers are only able to book a limited portion of the business offering.

Barrow.—Makers having very little iron to sell, are holding for high prices, 77s. 6d. to 80s. per ton for mixed Bessemer numbers, net f.o.b., while warrant iron is depressed by a Glasgow ring, and is lower on the week at 72s. 4d. net cash sellers, 72s. 3½d. buyers, yet during the past week stocks have been decreased 5982 tons, which leaves stocks now in hand at 204,858 tons, or an increase since the beginning of the year of 28,879 tons. There are 47 furnaces in blast, as compared with 41 in the corresponding week of last year, and two of the 47 are on spiegel.

Iron ore commands a very good sale, and the yield of the district is far below the requirements of smelters, who are importing large supplies of ore from Spain. Native sorts are quoted at 16s. 6d. per ton net at mines, and best sorts are at 20s. The latter quotation represents also the current market value of Spanish ores of good quality.

In the steel trade there is much briskness and activity, and orders are being offered to a very considerable extent, especially for heavy classes. Heavy steel rails are in very full inquiry on home, colonial, and foreign account, and business in steel ship plates remains very satisfactory. The demand for all other descriptions of steel is very fully maintained, and all departments of local steel works are as busy as can be. Prices all round are very satisfactory. There is a very steady and regular tone in the shipbuilding and marine engineering trades, but no new orders are noted. Builders are all very busily employed.

In coal and coke a full trade is doing, and orders are decidedly plentiful, although prices are fuller.

Shipping is busy. Exports last week reached 10,582 tons of pig iron and 14,738 tons of steel, being an increase on the corresponding week of last year of 3160 tons of pig iron and 4658 tons of steel. The aggregate shipments this year have reached 523,869 tons of pig iron and 483,517 tons of steel, being an increase of 19,975 tons of pig iron and a decrease of 20,648 tons of steel, as compared with the corresponding period of last year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE work of the year is within a day or two of being practically completed. The close of 1899 finds the coal trade in an exceptionally prosperous state, the demand for all qualities largely exceeding the supply. House coal has been stimulated by the winterly weather, and the congestion of the railway lines, through the inability of the companies to handle the traffic, has had serious effects in several of the large works as well as at the pits. Stoppages have been frequent and exasperating. House coal has again been advanced. Best Silkstones are easily saleable at 13s. to 13s. 6d. per ton; Barnsley house, 12s. to 12s. 6d. In steam coal, Barnsley hards fetch readily 11s. 6d. to 12s. per ton; seconds, from 10s. per ton. Gas coal continues in very brisk request. In engine fuel nuts are at 8s. to 9s. per ton; screened slack, 7s. per ton; pit slack, 6s. per ton; coke, which has risen 8s. 6d. per ton on the year, is now at 20s. to 21s. per ton.

The railway companies have completed their arrangements for future supplies on the general basis of 10s. 6d. per ton, the contract of the North-Eastern being subject to a month's notice on either side at the end of the half-year. The advances in locomotive fuel represent increased values of 2s. to 3s. per ton. The arrangement to concede the extra 5 per cent. to miners is accompanied by an agreement to continue for a further period of three years the Conciliation Board, which would otherwise have terminated at the end of 1899. This means peace in the coalfield.

The prices of hematite pig iron have steadily advanced during the year. For West-Coast the price on January 1st was 67s. 6d. per ton, rising in April to 69s., in July to 78s., in October to 86s., and on December 14th, 96s. 6d. At the corresponding periods of 1898 the quotations were:—January, 59s.; April, 59s. 6d.; July, 61s.; October, 64s.; December, 66s. In 1897 the price at the opening of the year was 61s., rising in April to 69s., at which figure it remained until the end of the year. North-East Coast irons are about 2s. per ton less than these prices. The quotation at the end of 1899 represents the highest point reached for the last twenty years. In 1880 there was a great American demand, which caused hematite pig iron to jump up to £6 10s. and even £7 per ton; but these extreme quotations lasted but a short time. To a similar cause is partly attributable the existing high values. The Americans have ceased to be sellers in our markets—they have even given up Canada for the moment—and are unable to meet the home requirements, buying freely in the British markets for that purpose.

Common forge irons have varied in sympathy. On January 1st the price was 46s. 6d.; April 1st, 43s.; July 1st, 62s. 6d.; October 1st, 68s. 6d.; December 14th, 72s. 6d. In 1898 the figures were: January, 41s.; April, 42s. 6d.; July, 43s. 6d.; October, 44s. 6d.; December 14th, 45s. 6d. In 1897: January, 41s. 6d.; April, 40s. 6d.; July, 40s., at which figure the price stood till the end of the year. Now the demand is so heavy that there is every prospect of further advances, the output being quite inadequate.

During the past year the British Government has placed orders for armour as follows:—

Battleships.

Name of vessel.	Built or building.	Description of armour.
H.M.S. Implacable	.. Devonport ..	Citadel, gun shields
,, Formidable	.. Portsmouth ..	Barbette (upper tier), gun shields
,, Irresistible	.. Chatham ..	Barbette (upper tier), gun shields
,, Vengeance	.. Barrow	Gun shields
,, Russell	.. Jarrow	Bow protection
,, Exmouth	.. Birkenhead ..	Bow protection
,, London	.. Portsmouth ..	Citadel, barbette
,, Venerable	.. Chatham ..	Citadel, barbette, protection (bow)
,, Bulwark	.. Devonport ..	Citadel, barbette, bow protection

First-class Cruisers.

,, Drake	.. Pembroke ..	Citadel, bow protection
,, Euryalus	.. Barrow	Barbette, casemate, conning tower
,, King Alfred	.. Barrow	Citadel, bow protection
,, Leviathan	.. Clydebank ..	Citadel, bow protection

The additions to the plant and extensions to premises in the armour plate mills, rendered necessary by the new processes of manufacture and the increased requirements by the British Admiralty, are now practically completed, and will enable the three firms during the new year to produce armour at their full capacity, which will be at least 30,000 tons per year. The work is, indeed, being very expeditiously turned out at the present time. In proof of this it may be stated that one of the latest battleships has recently received the whole of her citadel armour of over 1000 tons in less than six weeks from one firm; in fact, armour is being delivered quite as rapidly as it can be taken in hand at the dockyards.

In shot and shell there has been a similarly busy demand, largely owing to the quantities required to replenish Woolwich Arsenal, where stores have been depleted through the war. The Hadfield Steel Foundry Company and Thomas Firth and Sons have been very busy on this account. Some good American orders have been placed with the Hadfield Company.

Mercantile marine material is another branch in which much important work has been done, and the orders in hand are adequate to keep the works employed for nearly the whole of next year. There has been very little foreign work during the twelve months.

In railway material the difficulty has been to meet the various companies' requirements in wagons, and the accessories of rolling stocks. The Midland Company are now building a large number of their own wagons. Tires and axles have gone up on the year from £3, and in some instances £3 13s. per ton.

In steel there has been an increase of value all round; crucible, Bessemer, and Siemens-Martin have all advanced. Steel billets are from £3 to £4 per ton higher than a year ago.

In the lighter trades, such as cutlery, silver, and plated goods, there has been a heavy weight of work, but orders have been most unevenly distributed. The South African war, which has stimulated all the departments of military manufactures, has told most prejudicially against the older staple industries in South Africa, much value in orders remaining in suspense. At the Cape, in spite of recent reverses, the merchants are hopeful of the issue, and have warned local firms to be ready for the revival which is certain to come after hostilities have ceased, and the various regions affected begin to settle down under the British flag.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE continued and rapid fall in the prices of warrants this week is rather a surprise to business men, for there is nothing in legitimate trade to justify it, that being as satisfactory in all respects as ever it has been. It is speculative operations pure and simple that have brought about the heavy drop in the value of warrants, and on this account there has been this week something like a panicky feeling raised on the warrant market, which, however, has had little influence, so far as regards prices, on the regular market, though it has naturally caused consumers to refrain from buying. No one cares to purchase when warrant prices are falling, however that fall may have been brought about. Accordingly, business in pig iron has been almost at a standstill this week. During the first three days of this week Cleveland warrants fell 2s. 9d. per ton, making 5s. 4½d. decline for the month. The London speculators in warrants were responsible in the summer for no small part of the advance, as they bought freely. Now it is said that it is their action that is the chief cause of the heavy fall, for during the last few days they have been forcing their warrants on the market to be sold at any price they will fetch, as they do not wish to carry the iron over the winter with money at such a high rate as it is, especially when it promises to be still higher. The expense would be very considerable, and more than they care to incur. The period of the year favours "bearing" operations, as it is always a dull time in December, so far as the transaction of new business is concerned, and there have this month been other disturbing influences, *e.g.*, the unsatisfactory intelligence from the seat of war, the failure of some of the speculators in other metals, and the high price of money. The "bear" party have made the most of their opportunities.

But while the erratic course of the warrant market has naturally caused a curtailment of regular business, it has not led to any material reduction in the prices of pig iron. Thus, though Cleveland warrants dropped on Wednesday to 63s. 1½d. cash, No. 3 Cleveland G.M.B. pig iron was quoted at 70s. by the makers, and as indicative of the views of legitimate sellers and buyers relative to the future, it may be reported that considerable quantities of this quality have been sold for delivery over next half-year at 70s. The minimum asked by producers is 69s., and they do not see why they should take less, as they are well sold already for next half-year, and can afford to wait for better prices, which are likely to be realised in the spring, if not before. The cost of production has increased so much that it will be necessary to keep selling prices up. They are 50 per cent. higher than they were at the commencement of the year, but it must be remembered that the cost has gone up in proportion, ore having risen 50 per cent., coke 60 per cent., and wages at least 20 per cent. during the year. Coke, in fact, is now relatively dearer than pig iron. It is generally considered that the price of coke should be about one-third of that of pig iron, but the average of 25s. for blast furnace coke, delivered on Tees-side, which is the price to-day, is considerably more than one-third. Merchants have sold No. 3 Cleveland G.M.B. pig iron at 68s., but only in small quantities, as the tonnage under their control is comparatively small. No. 1 is quoted at 71s. 6d. by makers, but merchants have sold at 69s. For No. 4 foundry, 66s. 6d. is the price.

It is rather curious to note how steady the prices of forge iron are, and that they are actually dearer than No. 3. Grey forge is ordinarily 1s. below No. 3, and it has during the present year

been as much as 4s. 3d. below, but this week, while No. 3 has been offered at 66s., grey forge has been sold at 67s. 6d., and the prices quoted for mottled and white have been up to that figure also. But the position is different, the makers have not the market to themselves so far as No. 3 is concerned, because warrants compete. As regards forge iron, they have the market almost entirely in their own hands; there is very little under merchants' control, and those who want these qualities have usually to go to the makers direct for it. None is now to be found in the warrant stores, for forge iron has not of late years been lodged there, there being no surplus. The value of forge iron, therefore, does not fluctuate to the same extent as that of No. 3.

Hematite pig iron continues in larger demand than supply, and though West Coast warrants have fallen a good deal in price it has not affected makers' quotations either in this district or on the West Coast. Hematite warrants have been as low as 71s. 7d., but sellers of mixed numbers have not been ready to take less than 80s., and most makers hold out for 82s. 6d., but these are nominal figures in the absence of business. Rubio ore is strong at 21s. per ton delivered at wharves on Tees or Tyne, and it is difficult to buy at any lower figure.

The shipments of pig iron from the Cleveland district maintain for December the characteristics of the year—the best on record. There has never been a December when the exports have been larger; up to Wednesday night they reached 60,057 tons, as compared with 62,182 tons last month, and 53,460 tons in December last year, to 20th. The stock of Cleveland pig iron in Connal's warrant stores on the 20th was 72,080 tons, a decrease of 2364 tons this month, the decrease for the year being fully 47 per cent. Of hematite 9503 tons were held—1165 tons decrease for month, and 70 per cent. for year.

The manufactured iron and steel industries continue exceptionally busy—indeed, they have not been so well situated for a quarter of a century at least—and they look forward very hopefully to 1900, as they are already so well supplied with contracts for next half-year's execution that the year promises to be an even better period than that of 1899 has been. There is no sign in any branch of prices easing or trade falling off. Prices, in fact, are extremely stiff, and the tendency is rather upward. The quotations are now the best of the year, and they have risen all the year steadily without a single "set back." Not less than £8 15s. will be accepted for common iron bars, especially as more is secured in other districts, and manufacturers here have no difficulty in getting it. Iron and steel plates are at £8, ship; and £9 5s., boiler; while iron and steel angles are £7 15, ship; and £8, engineering, at works. Heavy steel rails are firm at £7 net at works.

The enlargement of the Middlesbrough dock is proceeding at a good rate, but the new port is not likely to be available for use within the next two years. The North-Eastern Railway Company, the owners, have given orders to Cowans, Sheldon, and Co., Limited, Carlisle, for an electric installation for the new port, which will not only be electrically lighted, but have three 10-ton and seventeen 3-ton electric cranes, besides electric capstans, &c.

The coal trade is in all respects satisfactory, and prices are at the highest figures known, not only this year but for many years, especially for steam coal, which is usually in quiet request at this time of the year, but now is in such good demand that it is difficult for the coalowners to satisfy the requirements. The Admiralty have bought a considerable quantity of North Country coal, as Welsh coalowners are so busy that they find it not easy to furnish more. Within the last few days an order for 20,000 tons of steam coal for shipment to South Africa has been divided between the Cowper and Bothal Collieries in Northumberland, and the price to be paid is 15s. f.o.b. Generally the quotation for best steam coal is 14s. 6d. f.o.b., and small 8s. to 8s. 3d. It has been publicly stated by one of the officials of the North-Eastern Railway that the Company's coal bill will be £140,000 more next year than it is for this year—they have had to pay 2s. 6d. to 3s. 6d. per ton more for their coal; indeed, prices have gone up fully 25 per cent. Considerable quantities of steam coal are being sent to the West Coast of South America. The price of best Durham gas coal has been raised to 15s. per ton, and bunker coal is from 13s. 6d. to 14s. The price of coke is rapidly advancing, best foundry coke, which could last week have been bought at 30s., being now at 32s. 6d., and some sellers quote 35s. f.o.b. Medium blast furnace coke for next half-year's delivery is raised to 25s. per ton, and there is very little offering at that. The death is reported of Mr. Thomas Wardle Asquith, of Harperley Hall, near Audfield Plain, Durham, the chief agent and supervisor for James Joicey and Co., at their Beamish and Tanfield group of collieries. His age was fifty-nine years, and he was a native of South Shields. He served his apprenticeship under the late Mr. John Swallow, at Harton and Hilda Collieries in that district. Afterwards he was at the Seaton Delaval Colliery, also the Walbottle Colliery. For some years he had the superintendence of the Cowper Collieries, under the well-known mining expert Mr. George Baker Forster.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron warrant market has again been very depressed this week, the same causes operating as before, namely, the unfavourable war news, and less satisfactory despatches regarding the state of trade in America, together with the increase in the price of money. Scotch warrants have sold from 66s. to 63s. 11½d. cash, and 66s. 6d. to 64s. 4½d. one month. Cleveland warrants have been done from 65s. to 63s. 6d. cash, and 65s. 6d. to 63s. 6d. one month. Transactions have taken place in Cumberland hematite warrants from 72s. 10½d. to 71s. 4d. cash, and 73s. 6d. to 71s. 9d. one month. The fall in warrants from the highest point is now very severe. The consumption of pig iron at home is well maintained, and so far as can be ascertained is likely to continue good for a considerable time. Lower prices for raw iron will be a decided advantage to the manufacturers.

The prices of Scotch makers' iron are as follows:—Govan, at Glasgow, No. 1, 67s. 6d.; No. 3, 66s. 6d.; Monkland not quoted; Wishaw and Carnbroe, Nos. 1, 77s.; Nos. 3, 74s. 6d.; Clyde, No. 1, 83s.; No. 3, 78s.; Gartsherrie, No. 1, 84s.; No. 3, 78s. 6d.; Summerlee, No. 1, 84s.; No. 3, 79s. 6d.; Calder, No. 1, 83s. 6d.; No. 3, 78s. 6d.; Coltness, No. 1, 88s. 6d.; No. 3, 79s.; Shotts, No. 1, 83s. 6d.; No. 3, 78s. 6d.; Glengarnock at Ardrossan, No. 1, 82s.; No. 3, 76s.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, Nos. 1, 78s.; Nos. 3, 75s.; Carron at Grangemouth, No. 1, 85s.; No. 3, 78s. 6d. per ton.

The furnaces in blast in Scotland number 83, compared with 82 at this time last year; and of the total, 41 are producing hematite, 37 ordinary, and five basic iron. The furnaces making basic iron at Glengarnock have been increased since last report from four to five.

The price of Scotch-made hematite has fallen 2s. 6d. per ton, and is now quoted 82s. 6d. for delivery at the steel works. The likelihood is that hematite prices will go lower, especially as stocks have been increasing in the North of England.

The shipments of pig iron from Scottish ports in the past week have amounted to 4111 tons, compared with 4601 in the same week of 1898. There was despatched to the United States, 50 tons; South America, 75; India, 121; Australia, 682; France, 65; Germany, 10; Holland, 653; Belgium, 290; Spain and Portugal, 20; China and Japan, 125; other countries, 65; the coastwise shipments being 1955, as compared with 2974 tons in the corresponding week of last year.

The stock of pig iron in Glasgow warrant stores continues to decrease, having fallen 3670 tons in the past week. The foreign demand at the moment is comparatively quiet, and it is not likely that much will be done for export during the remainder of the year.

The finished iron and steel trades are very busy, but there is no new feature of importance to notice. Prices of manufactured articles are nominally unaltered.

The coal trade is very strong, in the West of Scotland particularly. The orders in hand, including the necessary supplies for the iron and steel works, are more than sufficient to keep all hands connected with the collieries busy until the close of the year. Fresh orders are generally accepted at the risk of those who give them, sellers not being able to guarantee delivery with anything like promptness. The prices of household coals were raised this week from 1s. to 2s. per 24 cwts., according to quality. There was a great rush of orders towards the end of last week in order to anticipate the advance, but coal masters were not sure whether they could deal with all these at the old prices. They are greatly dissatisfied with the advance in railway rates, as it came upon them quite unexpectedly, and because, in many cases, they will have to pay the extra charges out of their own pockets. This they will certainly have to do in the case of contracts, and annual contracts form a very considerable proportion of the business of the Scottish collieries. The coal shipments in the past week are from 8000 to 9000 tons less than the preceding week, but they are still a good average for the season, and there are at present inquiries in the market that will involve heavy shipments to the Continent, either from Scotland or the North of England, or perhaps partly from both.

The annual returns of the Clyde shipbuilding trade show that the output of the year now closing is the largest in the history of the trade. On the Clyde forty-one sailing vessels of 14,618 tons, and 243 steamers of 476,456 tons, making a total of 491,074 tons, were launched, compared with 466,832 tons, in the corresponding week of last year.

Marine engines turned out during the year are returned with an aggregate of 478,503-horse power, against 510,805 in 1898. The work in hand in the Clyde shipyards is roughly estimated at 430,000 tons, so that the prospects of the coming year as regards shipbuilding are very encouraging.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

EVERY week of late has witnessed a firmer tone, and an advance in price of nearly all kinds of Welsh coal. The forecast of 30s. per ton for best steam by Christmas—one time regarded as rather extravagant—seems likely to be realised, for within the last few days sales have been effected at 25s., and it will be seen by my quotations that the trade is distinctly in that direction. The scarcity of coal is at all parts a subject of comment, and it is known that the Government agents are again in the field placing business. This, and the ordinary demand, and the excellent state of the industries generally, all conspire in keeping coal prices up. During the last few days the demand for shipment during January at Cardiff has much increased.

Quotations must now be taken with reserve, as the closing figures on 'Change one day may be altered the next to a marked extent. Mid-week prices, Cardiff, were as follows:—Best steam, 24s. to 25s.; seconds, 21s. to 22s.; dry, 18s. 6d. to 19s. 6d.; best Monmouthshire, 19s. to 19s. 3d.; seconds, 17s. 9d. to 18s.; best steam, small, 11s. 9d. to 12s.; seconds, 11s.; best households, 18s. to 19s.; No. 3 Rhondda, 18s. to 19s.; brush, 14s. 6d. to 15s.; small, 12s. 6d. to 13s.; No. 2 Rhondda, 16s. to 16s. 6d.; through, 13s. to 13s. 6d.; small, 10s. 6d. to 11s.

General satisfaction is expressed in the Western district for the settlement of the various disputes which have so long blocked trade. It was reported on 'Change, Swansea, this week, that large coal was becoming very scarce, and that from most of the works complaints were pressing in respect of the scarcity of small. House coals are a long way behind demand, and prices of most on the up grade.

Swansea coal shipment last week was brisk, and would have been more so but for tonnage delayed by the storms. The total coal and patent fuel amounted to 61,000 tons. Patent fuel was in strong request, Italy taking 11,850 tons, Beyrouth 2500 tons, Tunis 1000 tons, France 240 tons.

Swansea coal prices are as follows:—Anthracite, 15s. to 16s.; seconds, 14s. to 15s.; ordinary large, 11s. 6d. to 12s. 6d.; small rubbly culm, 6s. 6d. to 7s. 6d. Steam coals: Large, according to arrangement; seconds, 17s. to 18s.; bunkers, 14s. 6d. to 15s. 6d.; small, 10s. 6d. to 11s., all delivered f.o.b. Swansea, cash 30 days less 2½. House coal according to arrangement. Patent fuel, 15s. to 16s. Coke: Furnace, 29s. to 30s.; foundry, 30s. to 35s. It will be seen that patent fuel and coke are advancing in ratio with coal. Cardiff prices, patent fuel, are 18s. to 20s.; coke, furnace, 26s. to 28s.; foundry, 29s. to 30s.; and specials, 35s.

The most important coal news of the week has been the retention of the Bute Collieries, the collieries of Lewis, Merthyr, and of the Abernant collieries lately under the direction of Mr. James Lewis, Plasdraw, Aberdare, in the ranks of the Coalowners' Association. Many rumours as to the cause of this have been rife, and conflicting statements common; but the fact of the matter is that it became known to Sir W. T. Lewis that there was a great rock ahead, the colliers openly urging that the arrangement for the inclusion of the western collieries was at variance with the sliding scale, as the western coals would seriously affect the audit, and, further, there was the fear that the men's intention to bring about a stoppage for this action by the end of the year would in all probability be carried out; and seeing the strong likelihood of this he withdraw the notices, and the collieries remain. I have grounds for stating that a good deal of pressure was brought upon Sir William to return and take up his old position at the head, but to this he has so far not yielded. The gratifying news was officially confirmed at a meeting of the Sliding Scale Committee, which was held in Cardiff on Tuesday, and largely attended by owners and workmen's representatives. Proceedings were duly opened, Mr. A. Hood taking the chair, and at an early period it was stated by the Chairman that it had been arranged that the notices of withdrawal at Lewis-Merthyr and the Marquis of Bute collieries, together with those lately owned by Mr. James Lewis, of Abernant, would remain in the association. In reply to questions he added that the coal from all these would remain in the audit. With regard to the coals from the collieries lately admitted into the Owners' Association in the western district, they did not propose to insist immediately upon the inclusion of their coals, and the matter would remain in abeyance. The workmen's representatives then submitted a previous application to employers, "That owners should deduct from workmen's earnings, by arrangement, an amount sufficient to defray the workmen's expenses in maintaining the sliding scale." This the Chairman promised to lay before the Coalowners' Association. Several disputes were next considered, and the most important referred by consent to arbitration.

The output of pig iron all through the district continues large, and imports of the same are well maintained. At Landore last week the make was considerable. At Dowlais there will soon be a large addition, one of the furnaces blown out lately for repairs is now being re-lined. I note that the Dowlais management contemplates a great extension in electric power; the idea is a large installation for the service of the Ivon and the old work.

The steelworks in all quarters are being worked to their utmost. Smelting furnaces are as busily occupied as it is possible to be, and the strain upon the bar-producing mills is unrelaxed. Blaenavon, Cyfarthfa, and Dowlais have been importing ore largely, and pig iron has come into the Newport district from Barrow. Newport has been sending large quantities of tin-bar to Bristol. Cardiff, 503 tons steel plates to Stettin and Danzig.

The export of rails and railway iron to Killindin has been resumed by the despatch of 1700 tons from Cardiff.

The vagaries of the pig iron market still continue, but do not affect makers' quotations, which show no sign of falling, and are in keeping with the present vigorous state of the finished iron and steel trade. Mid-week, on 'Change, Swansea, it was stated that during the past week Scotch pig iron warrants had fallen 2s. 1d., Middlesbrough 2s. 1½d., and hematite 1s. 11d. These warrants are affected the same as stocks and shares by the war news. Finished iron and steel prices are firm and advancing. Extreme difficulty is found in getting orders placed for anything like early delivery. The price of coal is telling upon the cost of make. Latest prices are:—Glasgow warrants, 65s. 4½d. to 65s. 10d. cash; Middlesbrough No. 3, 64s. 10½d., other numbers in proportion; hematite warrants, 72s. 3d. to 73s. for mixed numbers, f.o.b.; Cumberland according to brand; Welsh hematite, 85s., f.o.t.; Welsh bars, £9 to £9 10s.; angles at usual extras; sheets, iron and steel, £10 5s. to £10 10s.; steel rails, heavy, £7 10s. to £7 15s.; light, £8 10s. to £8 15s. f.o.t.; sleepers, according to section and specification. Bessemer steel: Tin-plate bars, £7; Siemens, £7 2s. 6d., all delivered in the district net cash.

Tin-plates: Bessemer steel, coke, 15s. 9d. to 16s.; Siemens, coke finish, 16s. to 16s. 3.; ternes, per double box, 28 by 20 C., 29s. 6d., 30s. to 34s.; best charcoal, 16s. to 17s.; big sheets for galvanising, 6ft. by 3ft. by 30 g. per ton, £14 15s. to £15; finished black plates, £12 15s. to £13; Canadas, £10 10s. to £11 5s.; galvanised sheets, £14 15s. to £15. Block tin, £104 5s. to £105. Copper, Chili bars, £72 to £69 17s. 6d. Spelter, £20 10s. Lead, £17 10s. All Swansea. Iron ore, Cardiff and Newport, Mon., best Rubio, 19s. to 19s. 3d.; Tafna, 17s. 6d. to 18s.

Pitwood is still scarce; Cardiff prices, 25s. per ton.

The trade continues in a flourishing condition. Last week the shipments were 41,386 boxes; receipt from works, 49,600 boxes; present stocks, 159,052 boxes. Labour market quiet. An authority on the trade states that, compared with last year, 76 more mills are working, and 3200 more men employed. At the end of November 412 sheet and tin mills were at work, and 20,482 workpeople employed. This gives at a glance the proportion of a great and flourishing industry. The American trade is rapidly improving. In November, 1898, the exports of black plate were only two tons. In November last the exports of tin-plate were 8711, as compared with 963 tons November, 1898. Taking the two years 1898 and 1899, the exports to all countries total 16,999 tons more this year than last.

The secretary of the steel smelters has effected a settlement at Cwmfelin.

One cargo alone of 9000 tons steam coal left Cardiff last week for the Cape.

In January the West Merthyr Colliery, Pontardulais, is to be brought to the hammer, with the whole of the machinery and plant.

Nixon coal, 300 tons, has been ordered for her Majesty's new yacht.

The Dowlais collieries now number 3500, all, with the exception of 120, as members of the Federation. At a meeting last week it was decided to have a "show cards day," and bring stringent measures to bear against non-members.

A fire occurred on the lower landing stage, Abercanard Colliery, Sunday, but by very able and energetic work it was got under, and work resumed Tuesday.

A Cape laden coal-ship also caught fire at Cardiff on Monday early, leading to the discharge of the cargo.

TRADE AND BUSINESS ANNOUNCEMENTS.—Mr. S. J. Burrell Prior, of 14, Abchurch-lane, London, E.C., has removed to 5, Laurence Pountney-hill, E C.—Mr. George Willis, a former pupil, and subsequently for several years assistant in the office of Mr. Joseph Swarbrick, M. Inst. C.E., of Manchester, has been appointed general assistant in the office of Mr. Joseph Corbett, Borough engineer, Salford.—Jeremiah Lyon and Co., being the sole proprietors of the business hitherto carried on by Colley and Co., at London, Birmingham, and Manchester, announce that on and after January 1st, 1900, they will conduct this business in their own name.—Christy Bros., of Chelmsford, have taken Mr. William Middleton, of Leeds, into partnership with them, and in future the name of the firm will be Christy Bros. and Middleton. —Mr. W. S. Laycock, Victoria Works, Sheffield, has opened a showroom at 77A, Queen Victoria-street.

ELECTRICALLY-DRIVEN PRINTING PRESSES.—Several of the large newspaper and magazine publishing firms now have some of their presses operated by electric motors, and the system is coming into increasing use. One plant alone has six direct-connected motors, supplied with current by ten 70-horse power dynamos. All these are on the Bullock system, using slow-speed motors. The speed regulation is obtained without waste of current, and without a large demand for current on starting the press. The press will start with one-third the current from the line that is required to run it at full speed. The press is under the absolute control of the operator, who can, by the controlling lever, start it slowly, inch it along for making ready, or bring it up to any of the several adjustments of the slow motion—one-twentieth of the normal speed—and thence run it at various intermediate speeds until the normal speed is reached. This speed variation permits of a much higher output than when the press is driven by belting. The variations are made without jerk or jar, and a number of push buttons are located on different parts of the press, by means of which it can be stopped instantly in case of a breakage of the paper, or other emergency. When one of these buttons is pushed an electric brake is applied, to take up the momentum of the press. The press cannot be started again until the controller lever has been set back to the starting point, so that it cannot be started suddenly. The motors are specially designed for this class of work, and run at very low speed. They exert a starting torque of three times the running torque, and have a reserve force for carrying overloads without injury. The motor is ironclad, and can be applied to the press in any position that is most convenient. Usually it is below the floor, suspended from the floor beams under the press, being connected to the driving shaft by a spur wheel and pinion. This leaves clear the space otherwise occupied by a driving belt pulley.

NEW ORLEANS DRAINAGE SYSTEM.—The city of New Orleans cover an area of about 24,930 acres, situated in a bend of the Mississippi River, and a large area is considerably lower than the high-water level of the river, being protected by levees or dykes. In laying out the new drainage system the river was abandoned as the outlet, as it would have been necessary to pump all the water over the levees. Lake Borgne was selected as the outfall, being only 4ft. below the level of the city. The main drainage canal runs through the lowest part of the city, affording the best opportunity for using the natural fall for the branch canals. Owing to the lack of sufficient natural fall, the main part of the city is divided into five sections. Each section has a pumping station, which lifts the drainage water of the section, and discharges it into the main canal. The main outfall is by a canal to Lake Borgne, but relief outfalls to Lake Pontchartrain are provided for times of excessive rainfall. There are eight pumping stations in all, five on the main drainage canal and three at the ends of branch canals, to discharge water into the relief outfalls. All the pumping stations are operated by electricity from one large power station, covering an area of 25,000ft., and so arranged as to allow of increasing the plant as the drainage works progress. The cost of the present plant, including the transmission lines to the three completed pumping stations, was £70,000. The open relief canals are from 4500ft. to 12,000ft. long, 33ft. to 50ft. and 80ft. wide, and about 12ft. deep, with slopes of 1½ to 1. New ones were made, and old ones improved by dredging. The covered canals through the city have concrete bottoms, inclined towards the centre line, and brick side walls, with the inner face inclined and the outer face vertical. The top width is 8ft. to 25ft., and the depth 6ft. to 9ft. The side walls support rolled steel joists, 7in. to 20in. deep, 4ft. apart, between which are sprung 9in. brick arches, levelled up to the joists with concrete. These canals pass underneath the streets.

NOTES FROM GERMANY.

(From our own Correspondent.)

FIRMNESS and healthy activity remain the characteristic features of the iron trades over here. Rhenish-Westphalian and Silesian ironmasters have been, during this week and the last, very briskly engaged, as fresh orders come in regularly, and there is plenty of work to be done in the next months, the order books being all so well filled. The sales lately effected in pig iron have been but moderate, owing to the increasing scarcity in this sort of iron. Deliveries in Luxemburg forge pig have been only small hitherto. On foreign account little business of importance is done, although makers of iron and steel are trying to satisfy their foreign customers as far as they are able; but as they often get more home orders than they can see their way through, acceptance of foreign contracts has now and then to be refused. Thus, in the Siegerland, fairly large foreign orders for spiegeleisen could not be accepted on account of the strong inland demand for that sort of iron. Quotations are much the same as lately given, M. 87 to 89 p.t. being quoted for spiegeleisen; white forge pig stands on M. 76 to 77 p.t.; common forge pig, M. 80 to 81 p.t.; Bessemer, M. 92 to 93 p.t.; basic, M. 84·50 to 85 p.t.; Luxemburg forge pig is sold at M. 94 to 95 p.t.; foundry forge pig No. 1 and hematite, M. 95; No. 3, M. 90 p.t. Scrap iron continues in strong request, but is much less scarce than formerly, heavy lots having recently been thrown on the market. Good qualities of Westphalian blooms are, as a rule, paid with M. 140 to 145 p.t., Siegers' best sorts going up as high as M. 197 p.t.

In the railway and engineering departments activity is as good as ever, and the higher rates quoted do not in the least check the demand, which promises to continue brisk for several months to come. Numerous orders are being placed, and as the improvement in nearly all trades and in general traffic compels the railway administration to increase their rolling stock, the machine and wagon shops are entering the new year with the most favourable prospects concerning employment. Not many weeks ago an order for 584 locomotives was given out by the Prussian State Railway Administration, and now again the said administration is reported to have been negotiating with locomotive shops concerning further supplies of locomotives for delivery next year. According to the *Berliner Börsen Courier*, the majority of the shops were, however, not in a position to accept contracts, or rather promise delivery for next year, except Hendschel and Son, in Kassel, and the Hanoverian Machine Company, which have promised to deliver forty locomotives in the last two quarters of next year. There is talk of a large tendering for locomotives taking place in February, 1900.

A vigorous demand continues to come forward in the coal trade. In house coal increasing animation is felt, owing to the sharp frosts we have had lately, and orders received during the week have been numerous and heavy. No alteration that would be worth mentioning has taken place in prices, but there is naturally a good deal of firmness shown. Deliveries of coal and coke in the Ruhr district were, for November of present year, 3,924,030 t., against 3,622 890 t.; in the Saar district, 557,990 t., against 532,690 t.; in Silesia, 1,512,160 t., against 1,501,210 t.: and in the three districts together, 5 994,180 t., against 5,656,790 t. for the corresponding period of last year. Increase was, accordingly, 8·3 per cent. for the Ruhr district, 4·8 per cent. for the Saar district, and 0·7 per cent. for Silesia. Total output during the first eleven months of the year was 42,221,960 t. for the Ruhr district, against 39,152,530 t.; 15,477,450 t. for Silesia, against 14,429,110 t.; 6,363,840 t. for the Saar district, against 6,128,870 t.; and 64,063,250 t. for the three districts together, against 59,710,510 t. for the corresponding period of last year. This production in the Ruhr district was 7·8 per cent. higher, in the Saar district 3·8 per cent., and in Silesia 7·3 per cent. higher this year than last.

A slackening off in the demand for girders and rails was felt on the Austro-Hungarian iron market, while bars and plates and general hardware are in pretty good call. Castings met with an advance of about 2 fl. p. q., and for some other articles a rise in prices has been deemed advisable in consequence of advances put on pig iron. Wire and wire nails, for instance, will be raised 1·50 fl. per 100 kilos., with the beginning of next year. Exports in iron from Russia have been showing a little more life recently, and as the prices are lower than in other countries, Austrian ironmasters have a fair chance of finding customers abroad. The rails sent to Italy, to which reference was made in last week's report, appear to have been for the greater part old rails from the Hungarian State Railways, which Italian rolling mills are going to use instead of billets.

To the Electric Joint Stock Company, of Vienna, an order has been given a short time ago to supply with electric light and power the ironworks in Alaghir, in the Kaukasus, which belong to a Moscow company.

Exports in Bohemian brown coal have been pretty heavy until last week, but will now come to a standstill almost, as the ice on the Elbe has been rapidly increasing. The trade in pit coal is strong in Austro-Hungary, and coke is also well inquired for, but is very scarce.

The general state of the Belgian iron market remains a thoroughly healthy one, although here and there a slight falling off in demand was reported, caused by the approaching holidays and by stock-taking, which is being done at many works towards the end of the year. Selling prices are high, and are very firmly maintained, both for raw and for manufactured iron. In the first weeks of December the following were the ruling quotations:—Luxemburg foundry pig No. 3, M. 110; forge pig, 100f.; basic, 105f.; merchant bars, No. 2, 225f.; for export, 215f. to 220f.; No. 3, 230f. for home consumption, and 220f. to 230f. for export; girders, 210f.; 205f. for export; angles, 235f.; plates, No. 2, 225f.; No. 3, 240f. for home and foreign consumption; steel rails, 160f., all per ton. Compared to November the above quotations all show a fair improvement.

The Belgian coal trade is extremely busy; the demand for all classes of coal rises, and so do prices, which have gone up very quickly since the beginning of December, and now, as severely cold weather has set in, and coal is getting more scarce than ever, the pits might ask almost any price, and would be sure to obtain it.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 7th.

THE meeting of Congress is attracting the attention of commercial, financial, and industrial interests to a greater degree than is usual. A number of vital questions come up for consideration. There is nothing to divide the National Counsel to a serious extent. The Philippine question is practically settled. The patching up of our currency system and the firm establishment of the gold standard will engage the attention of the banking and financial interests. The importing interests have a number of tariff modifications to ask for. The mercantile interests have settled upon a number of changes of the bankruptcy law they want, and will probably get. The shipping interests throughout the country have agreed upon certain changes they would like made in the inter-state commerce law. The shipping interests have their little budget of requests all ready. The Secretary of the Navy will favour the American registration of foreign tonnage. A parcel post law will also come up for discussion. In fact, there has not been a Congress for many years which will have to consider so many questions as this. The coming year is presidential year, and unless something unexpected happens—and the unexpected is always happening—the present incumbent of the White House will be the next candidate. The business interests want it that way. The silver interests have been largely scattered by the favourable conditions which have sprung up within the past two years.

The demand for all kinds of material continues heavy even now. The season has been an open one, and winter has hardly shown its nose. The engineering and machinery plants of the country are estimating on an enormous amount of work, much of it work that cannot be undertaken until next spring. Prices have been at a level for a month. Brokers in this city and representatives of the big combinations utterly repudiate opinions that weaker prices are likely to be developed in iron, steel, or raw material of any kind.

Prices in all kinds of commodities are steadily advancing, and the advances have no effect upon demand. Little shops and factories are springing up, and a great many more are to be built this winter. There is scarcely a manufacturing plant in the country but what is enlarging or contemplating enlargement. While manufacturers find fault with the high prices, and declare they cannot get corresponding prices for their products, they keep on buying and paying.

WIRE ROPES AND CHAINS FOR LIFTING AND TRACTION.

AT a meeting of the Manchester Association of Engineers on Saturday, amongst other topical questions brought forward for discussion was that of the relative merits of wire ropes and chains for lifting and traction. Mr. John Craven said there were merits in both wire ropes and chains for lifting purposes. One advantage of wire ropes was that any defect made itself visible, perhaps, in the detachment of some of the small threads of which the rope was composed, and consequently they had a warning, whereas if there were a flaw in a link chain it broke suddenly. Taking, however, a travelling chain working under severe conditions, that had to lift, say, 60 tons of hot metal, to the heat of which the wire rope would be subjected for about half an hour, in such a case the hempen core of the rope would burn, and the flexibility of the rope would be destroyed, and consequently a chain would be preferable under such conditions. There were arguments to be urged in favour of wire ropes, and also in favour of chains; it depended on their various applications. Mr. Fox said chains could not be compared with wire ropes for the lifting of large weights, and he had sling ropes at present at work lifting big loads, and they were being handled by the men in a way that would be impossible with a sling chain capable of lifting the same weight. Mr. Constantine referred to some cranes for quarry work that were fitted with wire ropes, and which were answering very satisfactorily. Mr. H. Hodgson considered wire ropes much better than chains for crane purposes. He also intended using wire ropes for blocks for erecting purposes. Mr. Bates said wire ropes might be useful for slings in an engineer's shop, but not in a tool works. He used hemp ropes. Mr. A. Saxon observed that for crane requirements, hoisting blocks, and various outdoor requirements, wire ropes had many advantages. Mr. Souttar said he believed in the merits of wire ropes for general crane work, but did not think they would be satisfactory in works where they manufactured heavy forgings.

The President—Mr. Henry Webb—submitted the question, "What is the readiest method of testing the permeability of metals for permanent magnets?" What was required, he observed, was not only a test of the electrical machine when it was finished and ready for going to work, but some means by which the man who made the castings or forgings for the magnets should be able to have the material cheaply and readily tested before sending out. As this question did not elicit any response, it was left over for discussion on some future occasion.

LAUNCHES AND TRIAL TRIPS.

BRENDA, steel screw steamer; built by, the Strand Slipway Company, Sunderland; to the order of, the Brenda Steamship Company, London; dimensions, 220ft., 35ft., and 15ft. 7in. draught; to carry, 1770 tons deadweight; engines, triple-expansion, 18½in., 30in., 49in., by 33in. stroke, pressure 160 lb.; constructed by, the North-Eastern Marine Engineering Company, Limited; trial trip, December 9th; 10 knots.

PARKSIDE; built by, the Londonderry Shipbuilding and Engineering Company, Limited; to to the order of, M'Vicker, Marshall, and Co., of Liverpool; dimensions, 372ft., 46ft. 3in., 28ft. 6in. to upper deck beams; to carry, 6200 tons deadweight; the first vessel launched by this firm; launch, December 9th.

LONDON BRIDGE, steel screw steamer; built by, Ropner and Son, Stockton-on-Tees; to the order of, Furness, Withy, and Co., Limited, for Moore, Innes, and Co.; dimensions, 325ft., 48ft., 24ft. 3in. moulded; to carry, 5000 tons deadweight; engines, tripie-expansion, about 1100 indicated horse-power, pressure 160 lb.; constructed by, Blair and Co., Limited; launch, December 15th.

SCHWARZENFELS, steel screw steamer; built by, Wigham Richardson and Co., Limited; to the order of, the Deutsche Dampfschifffarts Gesellschaft "Hausa," of Bremen; dimensions, 370ft., 46ft., 30ft.; engines, quadruple-expansion, pressure 210 lb.; constructed by, the builders; engines balanced on the Yarrow, Schlick, and Tweedy system; launch, December 16th.

EVERHINGHAM; built by, Blyth Shipbuilding Company, Limited; to the order of, Alen Meek and Sons; dimensions, 337ft., 47ft., 24ft. 10in.; engines, triple-expansion, 24in., 40in., 65in., by 42in.; constructed by, Blair and Co., Limited; trial trip, December 6th.

EDUARD BARY, steel screw steamer; built by, Ropner and Son; to the order of, Furness, Withy, and Co., Limited; to carry, 5200 tons deadweight; engines, triple-expansion, 1100 indicated horse-power; trial trip, December 12th.

ADRIANA, steel screw cargo steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, the British Maritime Trust, Limited; to carry, 4700 tons deadweight; engines, triple-expansion, 23in., 36in., 59in., by 42in. stroke, pressure 180 lb.; constructed by, T. Richardson and Sons, Limited; launch, December 16th.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

7th December, 1899.

24,332. FIRE BRASS BOWS and HANDLES, G. Smart, Birmingham.
24,333. LIFE-BELT, W. Jones, Croome, near Worcester.
24 334. INFLATORS and VALVES for TIRES, T. Stanton, Sheffield.
24,335. MACHINERY for SPINNING WOOL, G. H. Milward, Manchester.
24 336. UMBRELLAS, F. Sidebotham and P. A. Lunn, Manchester.
24,337. HEATING and LIGHTING APPARATUS, R. Maclaurin, Glasgow.
24,338. MACHINE for SHARPENING SAWS, J. Hill, Derby.
24,339. INDEXING BLANK BOOKS, L. Gillrath, Cologne.
24,340. TRACK for CIGAR-MAKING MACHINES, J. Haarer, Glasgow.
24,341. MANUFACTURE of ORNAMENTAL TUBES, F. Madeley, Birmingham.
24,342. HOSE LEAK PREVENTER, E. J. Denyer, Staines.
24,343. APPARATUS for PROPELLING BOATS, T. W. N. Kendall, London.
24,344. RAILWAY CARRIAGES, D. Macdonald, Kilmarnock.
24,345. PLUGS for WALL SOCKETS, H. Oppenheimer.—(*Actiengesellschaft Mix and Genest, Germany.*)
24,346. SHOE VENTILATORS, S. Arnsfield and J. Koller, London.
24,347. ATTACHING BUTTONS to BOOTS, W. E. Brock and H. B. Cranage, London.
24,348. SYSTEM of VALVES for ENGINES, A. F. Evans, London.
24,349. EXHAUST SILENCERS for ENGINES, A. F. Evans, London.
24,350. SPEED GOVERNORS for ENGINES, A. F. Evans, London.
24,351. LUBRICATION of ENGINES, A. F. Evans, London.
24,352. VACCINATION SHIELDS, A. S. Bowley, London.
24,353. PREVENTING SPONTANEOUS COMBUSTION of COAL, R. Threlfall, Birmingham.
24,354. COUPLINGS for RAILWAY VEHICLES, O. Kerr, London.
24,355. VALVES for PNEUMATIC TIRES, G. F. Griffin, London.
24,356. LAMP-LIGHTER, D. B. Metchin, London.
24,357. VEHICLE WHEELS, F. Westwood and P. L. Renouf, Yardley, Worcs.
24,358. NIGHT LATCHES, N. J. and J. E. Jones, Birmingham.
24,359. SYSTEM of ELECTRIC WIRING, G. H. Chard, London.
24,360. GAS APPARATUS, J. St. L. McGinn, London.
24,361. DRIVING CHAINS for CYCLES, F. F. Röthy, London.
24,362. PENS and PENHOLDERS, E. H. Butterworth, Manchester.
24,363. METHOD of FASTENING LEGGINGS, R. W. Shipway, London.
24 364. GENERATING ACETYLENE GAS, A. Rouma, London.
24,365. APPARATUS for DRYING HOPS, C. S. Meacham, London.
24,366. TURRET LATHES, J. Brockie, London.
24,367. STEAM GENERATORS, G. F. G. Des Vignes and W. A. Cloud, London.
24,368. BOTTLES, W. Henzenberger, London.
24,369. CYCLE BRAKES, H. de M. Wellborne, A. E. Hall, F. Oxborrow, and T. Mathewson, London.
24,370. ELECTRIC SWITCHES, D. G. F. White and J. Shaw, London.
24,371. CLASPS or CLIPS for TROUSERS, A. B. Herald, London.
24,372. A TOY, J. Shipway, London.
24,373. SAFETY APPLIANCES for DRAUGHT ANIMALS, J. Appleton, Liverpool.
24,374. STOPPERS or VALVES for BOTTLES, H. E. Deyes, Liverpool.
24,375. CHEMICAL CHIMNEY CLEANSERS, T. Huson, Liverpool.
24,376. WICKERWORK BASKETS, G. Waldschmitt, Liverpool.
24,377. EXPLOSIVES, L. Wenghöffer, London.
24,378 MUSICAL INSTRUMENTS, J. Wellner, London.
24,379. BOTTLE STOPPER, F. Houben and J. Wollenschläger, London.
24,380. EXPLOSIVES, J. E. Evans-Jackson.—(*U. Alvisi, Italy.*)
24,381. COIN-FREED APPARATUS, W. J. Daniels, London.
24 382. LAND CULTIVATORS, J. W. Moss, London.
24,383. WASHING GAS, S. Chandler, jun., J. Chandler, and Kirkham, Hulett, and Chandler, Limited, London.
24,384. REPEATING UPRIGHT PIANO ACTIONS, L. N. Soper, London.
24,385. COIN HOLDERS, J. R. Collins, London.
24,386. STEAM ENGINES, J. H. K. McKollum, London.
24,387. ELECTRIC LAMP, C. Van Deventer, London.
24,388. WEAVING LOOMS, J. A. Schaufelberger, London.
24,389. INCUBATORS, J. Dervilles, London.
24,390. FOLDING EDGES of CUFFS, H. H. Lake.—(*J. K. P. Pine, United States.*)
24,391. ROTARY EXPLOSIVE ENGINES, J. Strasser, De W. C. Taylor, and F Stoecker, London.
24 392. MANUFACTURE of GAS IGNITION PILLS, A. Martini, London.
24,393 FLYING MACHINES, R. M. Balston, London.
24,394. FLUID-PRESSURE MOTORS for FLYING MACHINES, R. M. Balston, London.
24,395. CHANGE SPEED GEARING, F. W. Lanchester, London.
24,396. SEE-SAWS, W. I. Russell, London.
24,397. TREATING YARNS, A. J. Boult.—(*J. Dolder, Germany.*)
24,398. TIMEPIECE MECHANISM, J. Bongard, London.
24,399. TEMPORARY BINDERS for BOOKS, E. Le M Heydecker, London.
24,400. BLANKET, F. J. Stohwasser and G. B. Winter, London.

8th December, 1899.

24 401. BRAKING GEAR for CYCLES, C. Merington, London.
24,402. FIRE-EXTINGUISHING APPARATUS, W. Miller, Glasgow.
24 403. "GORGET PATCHES" for OFFICERS' UNIFORMS, J. Wyatt, London.
24,404. TAPPING BARRELS, &c., C. Kirton, South Shields.
24,405. EXPANDING CUTTERS, C. E. Hayton, Manchester.
24,406. INCANDESCENT GAS BURNERS, W. Williams, Manchester.
24,407. SPINDLES of SPINNING MACHINERY, W. G. Heys.—(*E. Senn, France.*)
24,408. SANITARY PIPE MACHINES, J. Staley and J. Parker, Derby.
24,409. PNEUMATIC TIRES, J. and V. L. Mangnall, Manchester.
24,410. HIGH-PRESSURE FILTERS, J. H. Topham.—(*M. Macleod, United States.*)
24,411. CUES for the GAME of BILLIARDS, E. S New, Woking, Surrey.
24,412. DEVICE for COILING WIRE, J. W. Goundry, Stockton-on-Tees.
24,413. DOORS of OVENS, T. and G. Perry, Wolverhampton.
24,414. BLOCK for PRINTING LINOLEUM, A T. Sparshott, Glasgow.
24,415. WATER GAUGES, G. G. and M. S. Forbes, Glasgow.
24,416 ELASTIC TIRES, W. A. Turpin, Coventry.
24,417. BOOTS, W. Essex, Southampton.
24,418. PISTOLS, L. B. Taylor and E. H. Parsons, Birmingham.
24,419. LUBRICATING SPINNING FRAME AXLES, S. Hainsworth and H. Benn, Bradford.
24,420 BEETLING ENGINE, W. H. Kane, Ballymena, Ireland.
24,421. SPIRIT LEVELS, F. W. Musgrave, Leeds.
24,422. SLIDING BOX COVER, F. T. Johns, Manchester.
24 423. INCANDESCENT GAS BURNERS, J. Jackson, Coventry
24,424. CUTTING POINTS of CIGARS, D. Kinzinger, Manchester.
24,425. BOLTS for RIFLES, L. B. Taylor and E. H. Parsons, Birmingham.
24,426. WEIGHING APPARATUS, W. Timmermann and H. Dellschafft, Liverpool.
24,427. LUBRICATING SPINNING SPINDLES, E. Perkins, Preston.
24,428. SAWING MACHINES, D. Nadel, Berlin.
24,429. PURIFIERS for CEREALS, A. Crabtree and S. P. Garratt, London.
24,430. OPENING and CLOSING DIES, F. A. Errington, London.
24,431. ELECTRIC RATE INDICATORS, J. Harris, London.
24,432. WHEELS for CARRIAGES, J. Broad-Smith, London.
24,433. LAMPS for ADVERTISING PURPOSES, H. G. K. Horner, Dublin.
24,434. WEAVING NEEDLES, A. Banks, Birmingham.
24,435. VENT PEGS for BARRELS, &c., W. Meeds, London.
24,436. CASKS, R. Standen, London.
24,437. COIN-CONTROLLED MECHANISMS, The British Thomson-Houston Company, Limited.—(*F. P. Cox, United States.*)
24,438. ELECTRIC METERS, The British Thomson-Houston Company, Limited.—(*C. E. Holmes, United States.*)
24,439. ELECTRIC RAILWAY SYSTEMS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
24,440. SEARCH-LIGHT HELIOGRAPH, M. H. L. Clark, London.
24,441. AUTOMATIC FIRE-ALARM, L. Davoine, London.
24,442. BAYONETS, F. G. Cave and H. S. Stoneham, London.
24,443. ROWLOCKS, H. W. Fairbrass and F. Cundall, London.
24,444. MACHINE for "BREASTING" LOUIS HEELS, J. Hart, London.
24,445. DRYING or ROASTING COFFEE, J. Roger, London.
24,446. CHARGING STEEL-MELTING FURNACES, C. Burnett, London.
24,447. STORING ARTICLES of FOOD, G. H. Williamson and A Culpin, London.
24,448. EXPLOSION ENGINES, H. H. Lake.—(*J. H. Davis, United States.*)
24,449. KNOT-TYING DEVICES for WOOD-BUNDLING MACHINES, H. H. Lake.—(*W. Hindley, United States.*)
24,450. ELECTRIC TELEGRAPH APPARATUS, J. A. L. Dearlove and S. G. Brown, London.
24,451. STORAGE BATTERIES, H. H. Lake.—(*C. Bruno, Italy.*)
24,454. FOLDING BOXES, H. H. Lake.—(*J. S. W. Thompson and H. S. Washington, United States.*)
24,453. FOLDING BOXES, H. H. Lake.—(*J. S. W. Thompson and H. S. Washington, United States.*)
24,454. SELF-LOADING TRICYCLE SWEEPERS, B. J. B. Mills.—(*A. J. Reynolds, United States.*)
24,455. DYEING with SULPHUR DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
24,456. TEAPOTS, W. W. Stainthorpe, London.
24 457. STEAM-GENERATING APPARATUS, H. A. Fleuss, London.
24,458. SUPPORTING ELECTRICAL BRUSHES, R. B. Ransford.—(*La Compagnie Générale de Traction France.*)
24,459. SELF-IGNITING GAS APPLIANCES, J. O. Spong, London.
24,460. SPRING SADDLES for CYCLES, P. Köhler, Liverpool.
24,461. OPERATING GAS TAPS, H. Arnhold, Liverpool.
24,462. ADVERTISING, R. Hamilton and J. T. Johnson, Manchester.
24,463. PLUMMER BLOCKS BEARINGS, T. Kings, Birmingham.
24,464. TREATING COTTON, H. E. Aykroyd and P. Kraïs, Liverpool.
24,465. CLOSING the ENDS of TUBES, G. Wiltshire, Liverpool.
24,466. TOOL CASES for CYCLISTS, G. Wiltshire, Liverpool.
24,467. WATERPROOF SHEET, E. Edwards.—(*J. Minder, Russia.*)
24,468. CAMERAS, A. W. Penrose and H. A. Brown, London.
24,469. TREATMENT of IRON ORES, &c, S. Ganclin, London.
24,470. MANUFACTURE of CIGARETTES, O. Heilmann, London.
24,471. PROPELLERS for VESSELS, A. B. Kokernot, London.

24,472. HAIR CURLERS and CRIMPERS, L. J. Frecknall, London.
24,473. ACCUMULATORS, W. Majert, London.
24,474. VEHICLES, S. H. Berry and G. Seagrave, London.
24,475. METAL FASTENING, R. Haddan.—(*M. E. Raschlé*, ——.)
24,476. TIRES, F. Christ, C. Flaschar, and H. Schefter, London.
24,477. KNITTING MACHINE, A. J. Boult.—(*E. J. Franck, United States*)
24,478. EXTRACTING METALS from ORES, &c., S. H. Johnson, H. L. Sulman, and S. H. Johnson and Co., London.
24,479. CASTORS for FURNITURE, C. L. Newland, Bromley, Kent.

9th December, 1899.

24,480. CONSUMING SMOKE in FURNACES, E. Taylor, Blackburn.
24,481. SMOKING PIPE, C. F. G. Cooper, London.
24,482. HATS, &c., for PROTECTION AGAINST the SUN'S RAYS, C. A. Radice, Dublin.
24,483. CUTTING GROWING SUGAR CANES, C. McNeil, Glasgow.
24,484. CYCLING and WALKING SKIRT, J. H. Gaul, Edinburgh.
24,485. GRATES for COOKING STOVES, J. E. Keyt, Kingston-on-Thames.
24,486. WINDOW BEAD FASTENERS, J. H. Brown, Kingston-on-Thames.
24,487. EVAPORATING APPARATUS, M. L. Dunham, Kingston-on-Thames.
24,488. ADDITIONS to METALLIC COTS, T. W. Adshead, Birmingham.
24,489. DRAWING PINS, F. H Shaw, Birmingham.
24,490. PNEUMATIC TIRES, W. R. Swift, Birmingham.
24,491. INDICATING the WINNER of a RACE, J. Levi, Manchester.
24,492. CONTROL VALVES for HYDRAULIC MACHINERY, E. D. Morgan, Bristol.
24,493. BILLIARD CHECKER, J. G Dixon, Sheffield.
24,494. GAS MOTORS, W. J. Crossley and J. Atkinson, Manchester.
24,495. An ACETYLIDE CARTRIDGE, G. Wiltshire, Liverpool.
24,496. PROTECTIVE COATING for IRON WIRE RODS, O. G. Moseley, Manchester.
24,497. The "DIGEST KNIFE," E. D. Lewis, Bridgend.
24,498. DRILLING HOLES in BRUSH BACKS, T. Rushworth, jun., Manchester.
24,499. CIRCULAR LOOMS for STRAW HATS, J. J. Hoye, Glasgow.
24,500 LIFE PRESERVERS, L. Guillot and V. Pinguet, London.
24,501. TRAYS for CASH BOXES, T. A. Cooke, Birmingham.
24,502. GAS PRODUCERS, R. Thomson, Glasgow.
24,503. BELTS for the CURE of SPINAL WEAKNESS, W. M. Green, Glasgow.
24,504. FIRE-ESCAPES, W. Benbow, Kingston-on-Thames.
24,505. MACHINES for MAKING PAPER, T. Martin, London.
24,506. AERATED WATER BOTTLES, A. E. H. Lozé, Liverpool.
24,507. PLATTEN PRINTING PRESSES, E. T. Cleathero, London.
24,508. EJECTOR BLADES of LINOTYPE MACHINES, W. H. Lock.—(*The Mergenthaler Linotype Company, United States.*)
24,509. BAROMETERS, L. F. Comitti, London.
24,510. DRIVING GEAR for CYCLES, W. Y. Lambert and F. C. Liles, London.
24,511. WATER-HEATING APPARATUS, J. Winterflood, London.
24,512. EDUCATIONAL DEVICE, G. Challis, London.
24,513. FLOWER HOLDER, W. Baker, London.
24,514. ELECTRIC METERS, A. J. Boult.—(*F. Saldana, France.*)
24,515. PRODUCTION of FODDER, F. L. R. Plönnis, London.
24,516. DECORATING WALL SCREEN, A. E. Horton, Birmingham.
24,517. MAKING MINERS' CANDLE-STICKS, G. Stott, London.
24,518. INCANDESCENT GAS MANTLES, A. M. Plaissetty, Paris.
24,519. MAKING ARTIFICIAL SILK, A. M. Plaissetty, Paris.
24,520. INDICATOR for STEAM GENERATORS, G. H. Biddles, London.
24,521. REFRIGERATING APPARATUS, J. Barr, Liverpool.
24,522. PACKING FOOD, R. Alstead, Liverpool.
24,523. MILLS for GRINDING PURPOSES, C. H. Edwards, Liverpool.
24,524. ELECTRIC ACCUMULATORS, &c, G. Leve and The Monobloc Accumulator Syndicate, Limited, London.
24,525. PUNCHING MECHANISM, H. Hill, London.
24,526. TELEPOLE FIRELIGHTERS, R. Howe, Manchester.
24,527. RECEPTACLES, H. F. Laage, Berlin.
24,528. WRINGERS, W. H. Murton, W. S. Varley, and E. Murton, Keighley.
24,529. CUSHIONS, G. B. Jessop and J. Read, London.
24,530. PREPARING AERATED LIQUIDS, E. Delbecchi, London.
24,531. BOTTLES, W. Michel, London.
24,532. CLEANSING COMPOSITIONS, J. Foster, London.
24,533. GAITERS and LEGGINGS, J. Leighton, jun., London.
24,534. PAINT, T. Möller, London.
24,535. PULLEYS for MOTOR CAR GEARING, L. Rottenburg, London.
24,536. THERMO-ELECTRIC PILES, L. Gottscho London.
24,537. STAMP for DATING TICKETS, R. S. Scott, London.
24,538. LIQUID-VENDING APPARATUS, &c., R. Kann, London.
24,539. THEATRICAL APPARATUS, G. A. O. Conquest, London.
24,540. SCORING INDICATOR, F. W. Haddan and E. B. Powell, London.
24,541. WOODEN STOPPER MANUFACTURE, G. H. Chaise, London.
24,542. NETWORK PACKAGE FASTENING, M. Lapeyre, London.
24,543. FREE-WHEEL CYCLE APPLIANCES, W. Paisley, London.
24,544. DUMB-BELLS, E. Sandow, London.
24,545. SUSPENDERS for ATHLETES, &c., E. Sandow, London.
24,546. PHYSICAL CULTURE and DEVELOPMENT, E. Sandow, London.
24,547. PUZZLES, E. Sandow, London.
24,548. TIRES for WHEELS of VEHICLES, A. I. Rath, London.
24,549. OPTICAL DEVICE, C. de Vere and C. Hertz, Paris.
24,550. STAGE ILLUSION, C. de Vere and C. Hertz, Paris.
24,551. MIRRORS and TRANSPARENT GLASS, C. de Vere, Paris.
24,552. MAKING BRICKS, A. L. Maynard and J. Watts, London.
24,553. STEMMING TOBACCO, H. H. Lake.—(*W. Gray, United States*)
24,554. LABEL CASE or FLAP for TRUNKS, A. Thompson, London.
24,555. PRESERVING VEGETABLES, E. Laroche-Joubert London.
24,556. DRIVING and BRAKE GEAR for CYCLES, J. Marriott, J. D. Spencer, and Marriotts', Limited, London.
24,557. STEREOSCOPES and SLIDES, A. Pumphrey, Birmingham.
24,558. SPOUTS of TEA and COFFEE POTS, J. Munday, Birmingham.
24,559. VALVES, H. H. Lake.—(*The Ingersoll-Serjeant Drill Company, United States.*)
24,560. AUTOMATIC WEIGHING MACHINES, M. E. Reisert, London.
24,561. MAKING NITRO-CELLULOSE, &c., L. Morane, London.
24,562. WATER-TUBE STEAM BOILERS, C. D. Moberg, London.
24,563. TIES, A. Dixon, London.

11th December, 1899.

24,564. COAL TUB, H. Harrison, Liverpool.
24,565. REFRIGERATING APPARATUS, A. H. Tyler, London.
24,566. TIRES, J. Adair, Waterford, Ireland.
24,567. CONTROLLING DEVICE for ELECTRIC LIFTS, J. S. Stevens, C. G. Major, and E. C. and P. H. Stevens, London.
24,568. PRESSES for MAKING BRICKS, S. R. S. Batley, Southampton.
24,569. HEAT-RADIATING APPARATUS, J. G. Wagstaff, Manchester.
24,570. MAKING DOUBLING FRAMES, E. Ashworth, Manchester.
24,571. SECURING CORKS in BEER BOTTLES, J. Parry, Worcester.
24,572. MOTORS, J. Weller, London.
24,573. EGG WHISKS, J. A. Giles, Manchester.
24,574. GAME, B. I. Rylands, Harrogate.
24,575. DEVICE for SAVING LIFE at SEA, C. Bliault, Glasgow.
24,576. TWISTING MACHINES, S. Clough. Bradford.
24,577. PACKING CYLINDERS, J. McLachlan, Barrow-in-Furness.
24,578. GASHOLDER, E. L. Pease and A. B. Pease and Co., Limited, Stockton-on-Tees.
24,579. DISENGAGING TAP HOLDER, L. H. Bateman, Halifax.
24,580. JOINTS for GAS PENDANTS, W. Meynell, Wolverhampton.
24,581. HORSESHOES, S. T. Johns, Boyle, Co. Roscommon.
24,582. CONVERTIBLE COUCHES and SOFAS, H. Brown, Blackpool.
24,583. SADDLE for VELOCIPEDES, J. Munday, Birmingham.
24,584. COUPLING for RAILWAY VEHICLES, J. Will, Glasgow.
24,585. COPPER TIED PAINT DISTEMPER, W. Simpson, Glasgow.
24,586. FLUSHING APPARATUS, G. F. Matthewson, Nottingham.
24,587. CRUCIBLE or SMELTING POT, L. M. Becker, Birmingham.
24,588. GRANULATOR for METALS, L. M. Becker, Birmingham.
24,589. CHAIN GUARD for BICYCLES, G. Rew, Edinburgh.
24,590. MECHANICAL TOYS, G. F. Lütticke, Berlin, S.O.
24,591. POCKET SPEAKING APPARATUS, M. Fried, Berlin.
24,592. FURNACES for STEAM BOILERS, J. Proctor, Manchester.
24,593. BASKETS for PACKING FRUIT, M. C. H. Taylor, Worcester.
24,594. ELECTRIC CUT-OUT, F. E. Greenstreet and E. J. Selby, London.
24,595. MACHINE for SEWING BOOKS, W. Nasch, London.
24,596. SHUTTLE, R. T. Gillibrand, Manchester.
24,597. ROPE DRIVING in COTTON MULES, W. Widdop, London.
24,598. REGULATORS for GAS BURNERS, C. Knaeps, London.
24,599. CEMENT for JOINING MARBLE, I. Ramboux, London.
24,600. FEEDING APPARATUS for YOUNG STOCK, F. and E. Hampton, Worthing.
24,601. COPYING MACHINES, A. Klein, London.
24,602. CLAMPING and SUPPORTING PIPES, O. Fggert, Berlin.
24,603. CASH CHECK TILLS, &c., F. W. Baynes, London.
24,604. TIRE, A. E. Wright, Aldershot.
24,605. SUPPORTS for WINDOW CURTAIN RODS, W. J. Chesters, Liverpool.
24,606. BRAKE MECHANISM for CYCLES, C. J. Paffard, London.
24,607. LIGHT for ILLUMINATING PURPOSES, B. Acres, London.
24,608. GOVERNORS for GASWORKS, R. N. Smith, London.
24,609. AUTOMATIC SPRING MOTOR, A. Wetter, London.
24,610. RAISING LIQUIDS by COMPRESSED AIR, J. Lafon, London.
24,611. BUFFERS for SHIPS, J. Sauer and E. M. Goldbeck, London.
24,612. BUILDING TILES, J. C. Sellars, Liverpool.
24,613. PENHOLDERS, S. H. Crocker, London.
24,614. TELEPHONE SYSTEM and APPARATUS, E. E. Ries, London.
24,615. CASING TILES, P. J. B. Mills.—(*F. Pagnon, France.*)
24,616. JOINT-SINKER, W. T. Sears, London.
24,617. CONVEYING SYSTEM, A. J. Boult.—(*M. J. Foyer, United States.*)
24,618. ROLLING PINS, C. L. Pitcher, London.
24,619. DRAINERS for BOTTLES, H. W. Wright, London.
24,620. BOOT and SHOE LASTS, C. H. and F. J. Dale, London.
24,621. DOCK CONSTRUCTION, V. Windett, London.
24,622. CUTTING TEETH on WHEELS, L. F. A. Monneret, London.
24,623. FLUID-PRESSURE ENGINES, A. W. Ofeldt, London.
24,624. PERFORATORS, A. Fraser, W. Judd, and G. Draper, London.
24,625. FELT MANUFACTURE, R. B. Ransford.—(*M. Böhler, Germany.*)
24,626. ASSIMILATING PRINTED WORK, S. A. Neidich, London.
24,627. SIGNALS, M. Pfatischer, London.
24,628. TABLE for SEWING MACHINES, F. R. Schreiber, London.
24,629. TALKING MACHINES, W. L. Wise.—(*The Universal Talking Machine Company, United States.*)
24,630. VEHICLE LIGHTS, H. J. Haddan.—(*C. G. Smith, United States*)
24,631. RECEPTACLES for MATCHES, E. A. Gerken, London.
24,632. FRAMES for MOUTHS of BAGS, C. Bateman, London.
24,633. VEHICLES, W. H. Wheatley.—(*H. Cauzard, France.*)
24,634. LIGHTING RAILWAY CARRIAGES, C. A. Vicarino, London.
24,635. SETTING OFF IMPRESSIONS, C. H. Cohen, London.
24,636. FILES, M. Lindner, London.
24,637. VESSELS containing STIRRERS, H. A. Snow, London.
24,638. MANUFACTURE of AZO-DYES, C. Wülfing, London.
24,639. GYROSCOPES, W. P. Thompson.—(*Berliner Maschinenbau Actien-Gesellschaft vormals L. Schwartzkopff, Germany.*)
24,640. CARTRIDGE HOLDERS, E. Breuning, Liverpool.
24,641. BATTERIES, W. W. Pilkington and W. R. Ormandy, Liverpool.
24,642. BEARINGS, J. Aitken, Liverpool.
24,643. MAGNET FRAMES for MOTORS, J. Burke, London.
24,644. SCENT MANUFACTURE, &c., H. Mehrländer, London.
24,645. SYNCHRONOUS ALTERNATING-CURRENT MOTORS, C. L. Rosengvist, A. Bergtheil, and H. W. Young, London.
24,646. EFFECTING LOCKED STEP-BY-STEP MOTION, Eversbed and Vignoles, Limited, and S. Eversbed, London.
24,647. COMMODES for BEDROOMS, &c., H. Cowley, London.
24,648. VESSELS for CONTAINING FUEL, H. Cowley, London.
24,649. CATCH for HATS, T. W. Wood, West Melbourne, Victoria.
24,650. FLAT IRONS, E. Hedges, St. John, New Brunswick.

12th December, 1899.

24,651. FLUSHING WATER-CLOSETS, H. H. Lake.—(*J. Woodbury, United States*)
24,652. CUFF LINK, L. J. Peters, Tunbridge Wells.
24,653. BISCUIT HOLDERS, L. Bennett, Winchester.
24,654. SKATE, J. H. Stevenson, Edinburgh.
24,655. RIDDLES and SIEVES, C. McCallum, Glasgow.
24,656. PLANING IRONS and TOOLS, N. McDowall, Glasgow.
24,657. CIRCULATORS for HEATING WATER in PIPES, J. T. Cope, Birmingham.
24,658. CYCLES for MILITARY PURPOSES, F. Smart, Birmingham.
24,659. HOT COKE CONVEYORS, M. Graham, Leeds.
24,660. GASOGENE for BEER, A. Bruce, Glasgow.
24,661. CARRYING ANGLERS' HOOKS, R. B. Cantrell, Wolverhampton.
24,662. RACK and PULLEY for WINDOW BLINDS, J. Butterworth, Manchester.
24,663. SUPPORTING TANDEM VELOCIPEDES, W. Gunn, Manchester.
24,664. LATCHES for DOORS, H. Lomax and J. Tomlinson, Manchester.
24,665. TREATING YARNS, J. T. Pearson, Burnley.
24,666. REGULATION of ELECTRIC POTENTIAL in ALTERNATING-CURRENT TRANSFORMERS, F. Hamer, London.
24,667. CORSETS, E. A. Burnell and A. Alexander.—(*M. Bleicher and Co., Germany*)
24,668. ELECTRO-DEPOSITION of METALS, H. M. Punnett and H. M. Punnett, jun., Birmingham.
24,669. ROLLER GEARING, T. Foster, Manchester.
24,670. LOCKS and LATCHES, H. A. and J. E. A. Squire, Birmingham.
24,671. PELLETS for BLASTING PURPOSES, L. Davies, Glasgow.
24,672. STEAM GENERATORS, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
24,673. ELECTRIC CLOCKS, J. Butcher, Wolverhampton.
24,674. WINDOW-CLEANING APPLIANCE, J. C. Smith, Eastbourne.
24,675. DELIVERY APPARATUS, W. C. Cross, W. Poulter, and H. E. Lancefield, London.
24,676. BOOTS and SHOES, H. Thomann, A. Eitel, and F. Proeger, Halifax.
24,677. DRILLING MACHINE, J. Carruthers, Harburn by West Calder.
24,678. WRITING DESKS, P. Weise, Berlin.
24,679. SHAKER SCREENS, H. Heenan, London.
24,680. PROCESS for TAWING SKINS, G. W. Adler, London.
24,681. TIME RECORDERS and CARDS, W. le G. Bundy, London.
24,682 WICKETS or STUMPS for CRICKET, J. K. Oldfield, London.
24,683. BICYCLES, D. E. Norton, London.
24,684. LIQUID-FUEL BURNER, G. W. White, C. Bradshaw, and O. T. Gregory, London.

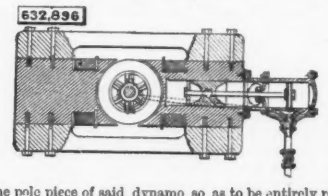
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

632,896. COMBINED ENGINE and DYNAMO, *C. C. Cowan, Memphis, Tenn.*—*Filed January 6th*, 1899.

Claim.—In a combined engine and dynamo, the combination of a dynamo, a separate engine bolted to

632,896

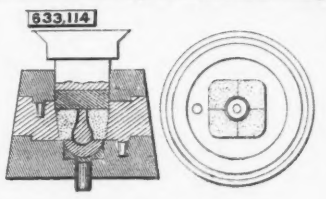


the pole piece of said dynamo so as to be entirely removable therefrom, and an engine guide or guides formed directly in said pole piece, substantially as set forth.

633,114. MACHINE for CONTRACTING SHEET METAL ARTICLES AROUND HARD METAL DIES, *W. M. Barry, Chicago, Ill.*—*Filed July 25th*, 1898.

Claim.—In an apparatus for contracting sheet metal, the combination with an exterior casing composed of sections, of a die, and a counter-die composed of sections formed of compressible material and arranged

633,114



in a cavity within the outer casing and around the die and shell to be formed, and underneath the same, and a plunger arranged above the die and counter-die and closely fitting the cavity above the same, substantially as and for the purpose set forth.

633,163. FRICTIONAL SELF-TIGHTENING FASTENING FOR CAMS, PULLEYS, &c., *L. T. Sicka, Denver, Colo.*—*Filed December 1st*, 1898.

Claim.—In combination with a cam, pulley, or

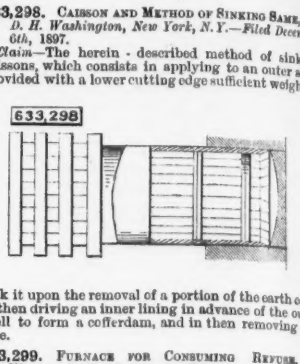
633,163

rotary body, a shaft provided with a recessed, excentric portion, a jib resting in the recessed portion against the excentric surface thereof and confined within the rotary body, and a key for forcing the body against the said surface, thereby forming a self-tightening fastening for the said body, and also preventing endwise movement, substantially as set forth.

633,298. CAISSON and METHOD of SINKING SAME, *W. B. H. Washington, New York, N.Y.*—*Filed December 6th*, 1897.

Claim.—The herein-described method of sinking caissons, which consists in applying to an outer shell provided with a lower cutting edge sufficient weight to

633,298

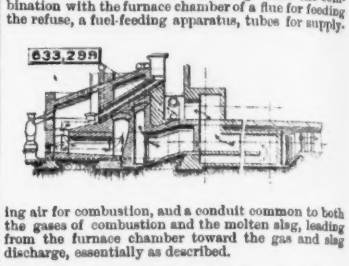


sink it upon the removal of a portion of the earth core, of then driving an inner lining in advance of the outer shell to form a cofferdam, and in then removing the core.

633,299. FURNACE FOR CONSUMING REFUSE, *C. Wegener, Berlin, Germany.*—*Filed October 10th*, 1898.

Claim.—In a furnace for consuming refuse the combination with the furnace chamber of a flue for feeding the refuse, a fuel-feeding apparatus, tubes for supply-

633,299

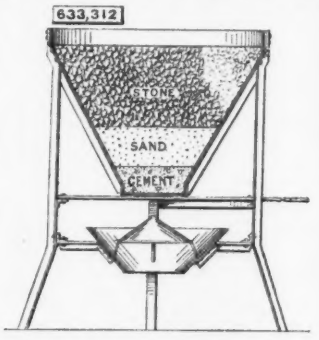


ing air for combustion, and a conduit common to both the gases of combustion and the molten slag, leading from the furnace chamber toward the gas and slag discharge, essentially as described.

633,312. PROCESS OF MAKING CONCRETE, *P. C. Hains, jun., and C. R. Weaver, Baltimore, Md.*—*Filed July 18th*, 1898.

Claim.—(1) The herein-described process of making concrete, which consists in supporting the several solid materials in separate horizontal layers arranged one above another, adding the requisite amount of liquid and discharging the materials by gravity at the bottom in a narrow stream, whereby the materials will be mixed as they are discharged, substantially as described. (2) The herein-described process of making

633,312



concrete, which consists in supporting the several solid materials, in horizontal layers, one above each other, said layers being arranged in accordance with the fineness of the material, the most finely divided being at the bottom and the coarsest at the top, adding the requisite amount of liquid, and discharging the material in a narrow stream at the bottom by gravity, whereby the several materials will be mixed as they are discharged, substantially as described.

633,367. CARRIAGE FOR FIELD GUNS, *A. Rexer, Essen, Germany.*—*Filed July 18th*, 1899.

Claim.—In carriages for field guns, a carriage stock pivoted to the wheel axle excentrically to the axis of the wheels, so as to allow a limited oscillation of the carriage stock around the axis of the wheels under the action of the weight and recoil; springs between the axles of the wheels and the carriage stock acting

633,367

in opposition to the tendency of the weight and recoil to turn the carriage stock around the axis of the wheels, and liquid brakes, likewise interposed between the axles of the wheels and the carriage stock, to take up part of the energy of the recoil, substantially as and for the purpose specified.

IT is reported in *Science* that the Russian Astronomical Society has finally given up its attempt to revise the Julian calendar. The reason assigned for its failure by the Society is "the impossibility of establishing an agreement between the dates of the religious festivals appearing in both calendars."

THE DEFINITION OF A "FACTORY" AND THE WORKMEN'S COMPENSATION ACT.

WE have now seen and carefully studied the Workmen's Compensation Act in operation for a period of nearly eighteen months. All the more important cases which have arisen during that time, whether in the County-courts or in the Court of Appeal, have been reported in these columns. In spite of the mass of litigation which has resulted from the Act, the stream still flows on relentlessly, no fewer than thirty-two cases having been entered for hearing at the commencement of the last sittings. A study of reported cases reveals the fact that the solution of the question, "What is the scope of the Act?" has given more trouble than any other problem submitted to the judges. Such expressions as "arising out of and in the course of the employment"—"on, in, or about a factory"—&c., involve the expenditure of much judicial time, and the outlay of much money in law costs by the parties engaged. Having regard to these difficulties of interpretation, which have forced themselves into a position of unpleasant prominence, it may be useful to investigate, and, if possible, explain those which are of more frequent occurrence.

If we recollect that the theory of universal compensation was, comparatively speaking, new when the Act was first mooted in Parliament, it is in one sense inexplicable that the framers of the Act should have had recourse to that extraordinary system of "legislation by reference" in their endeavour to delimit the boundary within which compensation was to be a necessary concomitant of accident. If the lawyer, to whom former Acts of Parliament dealing with factories, employers' liability, &c., are familiar, is hampered by constant back references, can the manufacturer, who purchases a copy of the Act in order to see how far it affects his relations with his employés, be expected to find a clear statement of his responsibilities? He cannot do so without referring to older Acts, and even then the untrained mind can hardly grasp the technicalities of law as deciphered from among a network of complicated sections.

To cope with all the difficulties which have arisen since August, 1898, when the Act first became law, would be outside the limits of this article. We shall content ourselves with pointing out how the definition of the term "factory"—or rather the absence of a satisfactory definition of that term—has given rise to many of the difficulties with which we are only too familiar.

In order to obtain a correct definition of the term "factory," we turn to Section 7 of the Act—the definition section. By that section: "The Act shall apply only to employment by the undertakers, as hereinafter defined, on or in or about a railway, *factory*, mine, quarry, or engineering work, and to employment by the undertakers, as hereinafter defined, on, in, or about any building which exceeds 30ft. in height, and is either being constructed or repaired by means of a scaffolding, or being demolished, or on which machinery driven by steam, water, or other mechanical power is being used for the purpose of the construction, repair, or demolition thereof." "Factory" has the same meaning as in the Factory and Workshop Acts, 1878 to 1891, and it also includes any dock, wharf, quay, warehouse, machinery, or plant to which any provision of the Factory and Workshop Act, 1895, applies, and every laundry worked by steam, water, or other mechanical power.

The term "factory" was defined by Section 93 of the Factory and Workshop Act, 1878, to mean both "textile factory and non-textile factory, or either of such descriptions of factories."

A textile factory includes premises used for the working-up of material into fabrics by the aid of steam, water, or other mechanical power.

The expression "non-textile factory" means:—

(1) Any works, warehouses, furnaces, mills, foundries, or places named in Part I. of the Fourth Schedule to the Factory and Workshops Act, 1878;

(2) Any premises or places named in Part II. of the said schedule wherein, or within the close or curtilage or precincts of which steam, water, or other mechanical power is used in aid of the manufacturing process carried on there;

(3) Any premises wherein, or within the close or curtilage or precincts of which, any manual labour is exercised by way of trade, or for purposes of gain in or incidental to the following purposes, or any of them, that is to say:—

(*a*) In or incidental to the making of any article, or of part of any article; or

(*b*) In or incidental to the altering, repairing, ornamenting, or finishing of any article; or

(*c*) In or incidental to the adapting for sale of any article; and wherein, or within the close or curtilage of which, steam, water, or other mechanical power is used in aid of the manufacturing process carried on there.

The following case affords an illustration of the extraordinarily roundabout method which has to be adopted in order to define a factory for the purposes of the Workmen's Compensation Act.

A workman was employed in a shed to look after a steam engine connected with a mortar pan for mixing mortar for use on a building near at hand. While so employed he sustained personal injuries through an accident, and brought a claim for compensation under the Act. For the purpose of succeeding it was necessary for him to show that the work upon which he was engaged came within the Act. By Section 7 of the Workmen's Compensation Act, 1897, as we have seen, "factory includes any . . . machinery . . . to which any provision of the Factory Acts is applied by the Factory and Workshop Act, 1895." Turning to that Act, we find that by Section 4 power is given to a court of summary jurisdiction to make an order as to a dangerous machine used in a factory or workshop. By Section 23, Sub-sec. 1 (*v*) (*b*) of the same Act, this provision, amongst others, "shall have effect as if any premises on which machinery worked by steam . . . . is temporarily used for the purpose of the construction of a building . . . were included in the word 'factory.'" It was decided that as the engine was being temporarily used for the purpose of the construction of a building, the provisions mentioned in Section 23 of the Factory and Workshop Act, 1895, had effect as if the shed were a factory; so that a provision of the Act, namely, Section 4, relating to the power to make an order as to a dangerous machine used in a factory, applied to the engine, which, therefore, came within the definition of a factory in Section 7 of the Workmen's Compensation Act, 1897, and compensation could be claimed under that Section. In this case, as was pointed out by Lord Justice Romer, the machinery in the shed was itself a "factory" within the meaning of the Workmen's Compensation Act, and this for the reason that under the provision of a former statute the justices are invested with power to make regulations with regard to dangerous machinery. Could any system of legislation be adopted which would effect a simple object in a more cumbrous manner?

Having ascertained whether the premises in question are a "factory" as defined by the Act, our difficulties are by no means at an end. The words "on, in, or about," which may be found at the head of Section 7 (*ubi sup*), at once arrest the attention, and have been made the subject of discussion upon several occasions in the Court of Appeal. Thus, in Lowth *v.* Ibbotson and Co. (15 T.L.R. 264), the facts were that a carter in the employ of the defendants was injured when occupied with his wagon at a distance of about 1½ miles from their premises. This was found as a fact by the learned County-court Judge, and the Court of Appeal refused to disturb his decision. A somewhat similar question arose in a previous case, where the following principle was laid down:—

"The question arises, what meaning is to be attached to the words 'on, in, or about?' It is obvious that the Legislature thought that the first two words were not large enough to cover all that they intended to include, and they, therefore, added the word 'about,' which is clearly an enlarging word. In my view that word means the employment may be in close propinquity to the factory, and whether that was so in this particular case is a question of fact to be determined by the tribunal before which the claim comes. The judge, in this case, has found that the deceased was employed 'about the factory,' and this brings the case within the statute." [Per A. L. Smith, L.J., in Powell *v.* Brown (1899), 1 Q.B., 157.]

We see, therefore, that the decision of this momentous question rests entirely with the County-court Judge, from whose ruling no appeal can lie, inasmuch as the question is one of fact.

The question whether a workman employed upon a job away from his master's premises, *i.e.*, in the factory of another employer, or in a private house, can maintain an action, has now been definitely decided in the High Court. The first case upon the subject came before his Honour Judge Stonor, who thought that the factory must be that of the workman's own master. In Belsey *v.* Sadler and Co., which was heard on Oct. 4th, the plaintiff had been sent to erect an hydraulic crane in a mill some distance away from that of his employers, the defendants. In spite of the argument which was advanced to the effect that if the employers were not to be held liable they could always escape responsibility by sending their men out, his Honour said: "I think the master's liability must be confined to accidents on, in, or about his own premises." In this he has been confirmed by the decision of the Court of Appeal in Francis *v.* Turner Brothers [16 T.L.R., 106], where it was decided that the words employment "in or about a factory," mean the factory which is occupied by the employers, and do not include employment at another factory.

A reference to the definition section shows that the term "factory" now includes a number of extraordinary places which are altogether out of keeping with the usual notion of a factory, and attempts have been made from time to time to extend the term to even greater lengths. Thus, in the case of Flowers *v.* Chambers [(1899), 2 Q.B., 142], an attempt was made to bring a ship in a dock within the scope of the Act, and this upon the ground that the dock itself and everything therein was a factory within the Act. The Court of Appeal refused to adopt this construction, and in the course of his judgment Lord Justice A. L. Smith said: "If the Legislature had intended that ships should be brought within the purview of the Act, it would have been perfectly simple to put the word 'ship' in the section; they have, however, chosen words expressive of certain localities to which the application of the Act is limited, and a ship is not one of them. We are asked to hold that a ship is a dock, and against such a holding I must emphatically protest."

Certain premises only become "factories" when machinery driven by steam, water, *or other mechanical power* is being used thereon. This raises an interesting question as to the meaning of mechanical power, and the general conclusion which may be drawn from the few cases reported is that any machinery set in motion by force other than human comes within the definition. The case of Bennett *v.* Aird, decided on October 12th, by Judge Stonor, at the Marylebone County-court, affords a good illustration. There the plaintiff had been engaged, with others, to break up a roadway for the purpose of laying water pipes. While driving the wedge, a head flew off one of the hammers and injured the applicant. It having been decided that he was at work upon the construction of a "sewer" (or something analogous thereto), it became necessary to decide whether "mechanical power" was being used for the construction, alteration, or repair thereof, so as to render him entitled to compensation. It was not argued that the use of wedge and hammer was the use of mechanical power, but it was urged by counsel for the applicant that inasmuch as a differential pulley block had been used to lower the pipes, mechanical power was used on the work. His Honour, however, refused to adopt this construction, saying "in 'Webster's Dictionary' the word 'mechanical' is given, amongst other meanings, the following: 'Acting by physical power,' and this would almost seem to meet the present case; but, on the whole, I think that the words 'mechanical power' ought also to be construed as *ejusdem generis* with those mentioned immediately before, viz., 'steam' and 'water,' which act automatically, and, generally speaking, continuously, after having been put into motion in the first instance by manual labour. I, therefore, on the whole, am of opinion that the present case does not fall within the Act, and give my award for the respondents without costs."

From this we may assume that any mechanical contrivance, however powerful, cannot be regarded as mechanical if driven by human agency.

The question whether the fines payable by persons who infringe the provisions of the Factory Acts, with regard to dangerous machinery, and through whose default injury is caused to a workman, can be set off against the compensation claimed, has fortunately been set at rest by Section 1 (5) of the Act. Under the Factory and Workshop Act, 1878, if any person is killed or injured in consequence of the occupier of a factory having neglected to fence any machinery or place under the Act required to be securely fenced, or to maintain the same, the occupier of the factory or workshops shall be liable to a fine not exceeding £100, the whole or any part of which may be applied for the benefit of the injured person or his family, or otherwise as a Secretary of State determines.

This is extended by the Factory and Workshop Act, 1895, Section 13, to any death or bodily injury, or injury to health in consequence of the occupier of a factory or workshop having neglected to observe any provision of the Factory Acts, or any special rule or requirement made in pursuance of the Act of 1891. Provided that in the case of injury to health the occupier shall not be liable under this Section unless the injury was caused directly by such neglect.

And now by the Workmen's Compensation Act, 1897, Section 1 (5), "Nothing in this Act shall affect any proceeding for a fine under the enactments relating to mines or factories, or the application of any such fine, but if any such fine or any part thereof has been applied for the benefit of the person injured, the amount so applied shall be taken into account in estimating the compensation under this Act."

BRITISH AND AMERICAN MACHINE TOOLS.

No. V.

COMPARATIVE FACILITIES FOR DELIVERY, AND METHODS OF SELLING.

WHEN the question of prompt delivery is considered, one finds that a purchaser in England can usually, in busy times, procure American more promptly than English machine tools. This is due to two causes. In the first place, American firms, as a rule, stock machinery in far larger quantities than the English manufacturers; and, secondly, nearly every American toolmaker of importance has his representatives or agents in this country, to whom he sends from time to time portions of his superfluous stock to be disposed of. It will thus often happen that a purchaser, when times are good, requiring a tool in a hurry to assist him in fulfilling a pressing contract, after applying in vain for immediate delivery from our leading makers, will find he is able to procure a machine to suit his purpose from among the representatives of American houses. Nor do our makers appear to consider this of any great importance. Seemingly, when they have sufficient work on their books to keep them busily employed for several months ahead, they are content to allow purchasers to go elsewhere for the time being.

Were it impossible to procure goods of equal quality from any other source, this policy could no doubt be continued without any ill effect, but when machines as good can be obtained from abroad in a much shorter space of time, and sometimes at even a lower cost, inability to supply demand is disastrous. Unless he can afford to lock up a large amount of capital, it is impossible for the English manufacturer to carry a complete stock, without which prompt delivery is impossible, with prudence, for, owing to the great variety he undertakes, he cannot with any certainty foretell what class of machinery he is likely to be called upon to supply. But the conditions in America are different. A firm which makes nothing but one type of machine is never asked to supply anything else; and can therefore continue to manufacture this one tool with tolerable certainty that a market for it will arise within a reasonable time.

Thus, when a purchaser is in pressing want of machinery, he can go to the various agents of American firms with the probability that he will be able to procure what he requires within a comparatively short space of time. It is true that if he is in need of a number of different machines he may have to divide his order between several different makers, but the chances are that among them all he will be able to satisfy his requirements. This does not apply, of course, to the very large machine tools, which are only, as a rule, made to order; when such is the case, English and American makers stand upon an equal footing; but the trade in light machinery is of sufficient importance to make the question of prompt delivery worthy of the most serious consideration.

Any manufacturer will in the abstract admit the necessity of preventing his regular customers from procuring their goods from other firms; but, in times such as these, when every one is full of work, the importance of this is very apt to be lost sight of. It is annoying to an individual requiring goods in a hurry to be told with a bland smile that he should have placed his orders long ago; and, as a large proportion of customers will always delay ordering until necessity compels them, it is im-

portant that our makers should be in a position to meet such demands without undue delay.

The last question to be considered is that of the methods adopted by both countries in the sale of their goods, and in this particular the American has of late come to the front with his usual activity. In the first place, his catalogues are usually far better got up and illustrated than the generality of those of English houses, and the letterpress, though not, perhaps, always remarkable for its literary merit, is full of practical information, and is well worth reading with attention. In fact, many American catalogues give the impression of having been written, not so much with a view to eulogising the goods offered for sale, as to affording a practical explanatory treatise by a specialist on some particular branch of engineering.

Again, when discussing the merits of a tool, one finds the American salesman most clear in his statements with regard to its capabilities. If shown samples of work required to be produced, he is able to inform the purchaser how many of such pieces his machine will turn out in a given space of time, and will often back a statement with the guarantee that he will send the machine to the customer's works, and, after it is fixed, send a man to work it; and if unable to prove his statements as regards output, the purchaser is at liberty to reject the tool. This method of conducting business inspires confidence.

Furthermore, the average American travellers are not only thoroughly practical engineers, but have generally been themselves employed in the actual manufacture and working of the machines they offer for sale; the consequence is that they are thoroughly acquainted with their smallest details, and are able to explain their features and answer questions as to methods of working in a most convincing manner. While the representative of an English house, after selling a machine to a customer, is accustomed to consider that his work is done, and, unless he receives a complaint, or sees a prospect of receiving a fresh order, will leave the purchaser alone for the time being; the American makes a practice of calling from time to time after his machine has been set to work to see how it is getting on, and if it is doing him credit. On these occasions his practical knowledge often enables him to offer useful advice on certain points, in connection with the working of the tool, and his visits are welcome in consequence. Our English makers might more generally adopt this plan with advantage to themselves. The principals, too, of American houses make a point of paying frequent visits in person to this country, and, in spite of the distance they have to travel, are to be seen more frequently in the offices of their English customers than the principals of our own machine tool makers, and thus the personal element, so useful in business, is introduced.

Having now considered the various points of contrast between English and American machine tools, and the methods in this connection employed by both countries, the causes which have influenced the advance of the tools produced by the latter become quite clear, and anyone interested in the engineering trade who is not prejudiced by circumstances and who desires to see his country maintain its position in this industry, cannot fail to view the present state of affairs with grave apprehension. It is not that we are without the abilities to do as well as others, for many of those controlling the most successful American workshops have been bred and educated in England, but our machine tool makers have held the supremacy so long that they are disinclined to admit the merits of machines produced by any other country.

It is true there are signs of an awakening to the fact that it is not good policy to ignore the merits, when such exist, of foreign-made machines, for a leading English firm not long ago sent a special commission over to the United States to study American machine tools and the methods of manufacture employed by that country—a decided step in the right direction. It is, however, much to be regretted that there not only exists among our makers great disinclination to alter patterns and bring their machine tools up to date, but a general lack of interest in the doings of foreign competitors is still apparent. The attitude of those present at the Conference of Civil Engineers, held last June, on the occasion of the reading of Mr. Arthur Greenwood's extremely able paper on machine tools—a report of which appeared in these columns—is indicative of this, for the apathy displayed on the subject is most noticeable in the discussion which followed. A paper on machine tools from such a source should have excited the keenest interest, and one would have expected to find a number of eminent machine tool makers expressing their views on the subject—views which, on an occasion of this kind, would have been most valuable. But, as a matter of fact, most of those present showed a decided disinclination to address the meeting at all. Two English manufacturers only appear to have spoken, one of whom was content to dismiss the question of American machines with a somewhat slighting comparison of them to a sausage machine, while the other admitted the fact that American machinery was handy in that most of the adjustments could be effected without the necessity of using a spanner. Neither of these statements can be said to have contributed largely to the value of the discussion. For the rest, all points of excellence in the American machine tools were either ignored or merely denied without any facts bearing on the subject being produced.

Although our manufacturers may refuse to admit improvements introduced by people of other countries, those using machinery cannot afford to do so; and, if a purchaser is unable to procure the very best tools from his fellow-countrymen, he will obtain his machinery elsewhere. It is to be hoped English makers will grasp the importance of this before it is too late.

To sum the matter up, if we are to maintain supremacy in the machine tool trade in the future, the following points must be borne in mind:—

(1) A more intimate knowledge of what is being done by others is essential. The time for concealing methods of manufacture has gone by, and a constant intercourse between makers is necessary to stimulate ideas, besides greatly increasing the opportunities of economic manufacture.

(2) The system of specialising and confining one's attention to a limited variety of work is necessary for the perfecting of any class of machine, and for the reduction of cost of manufacture.

(3) Those principles of trades unionism which tend to limit the capabilities of our working man, destroy his individuality and independence, or limit his capacity for production, must be eradicated.

(4) Our workmen must be prepared to extend their hours of labour to a number per week at least equal to those of other countries.

(5) Encouragement must be given to our workmen in suggesting improvements, and any legitimate ambition to better their position which they may possess should be cultivated. It is not too much to say that a very large portion of the success achieved by American machinery is due to the efforts of the American working man. Indeed, if the origin of many of the ingenious attachments on their tools be investigated, the larger portion of them will be found to have emanated from the workshop rather than from the drawing-office; while a number of the principals of the best manufacturing concerns in America at the present day have risen from among the ranks of this class.

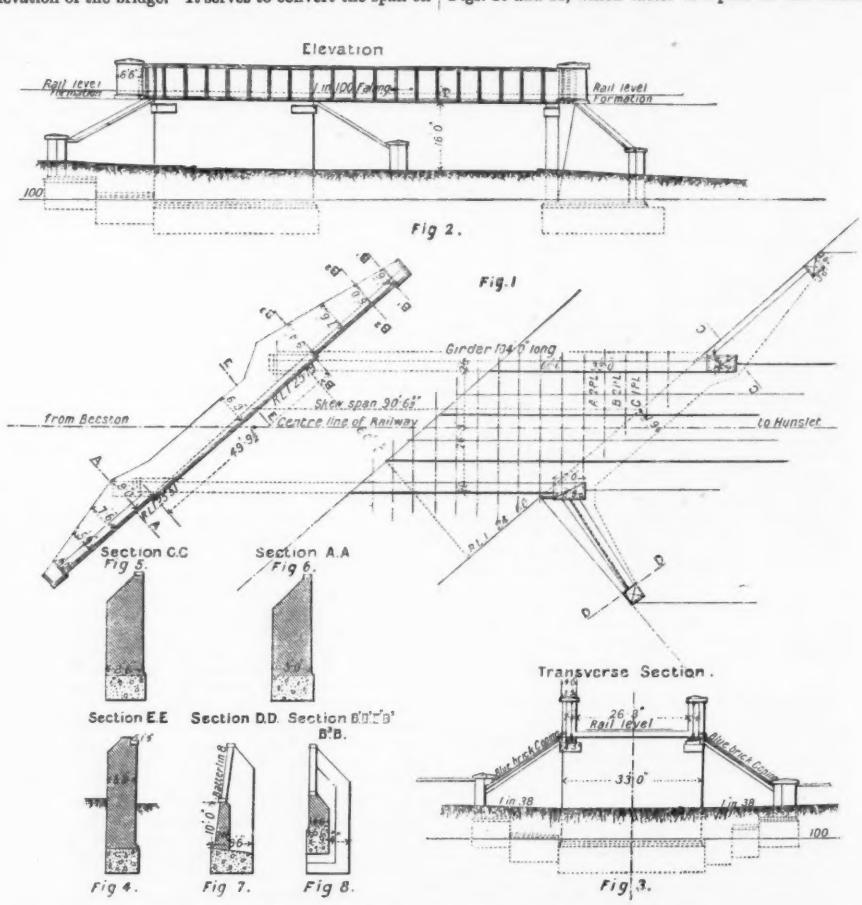
The success of the Americans in the manufacture of machine tools is put beyond question by the importations of the last few years, some figures of which were published at the commencement of this series. It has been the endeavour of this and previous articles to make clear the different causes which have led up to this, and to suggest points on which our own methods may be improved. With this in view it has been needful to emphasise what is good in American machinery and systems of manufacture, which may perhaps have given the opinions expressed an appearance of partiality. That we have much to learn is certain, and though the truth is not always palatable, to ignore it would prove fatal in the long run.

THE GREAT NORTHERN RAILWAY.

No. III.

NEW BRANCH LINE AND STATION AT LEEDS.

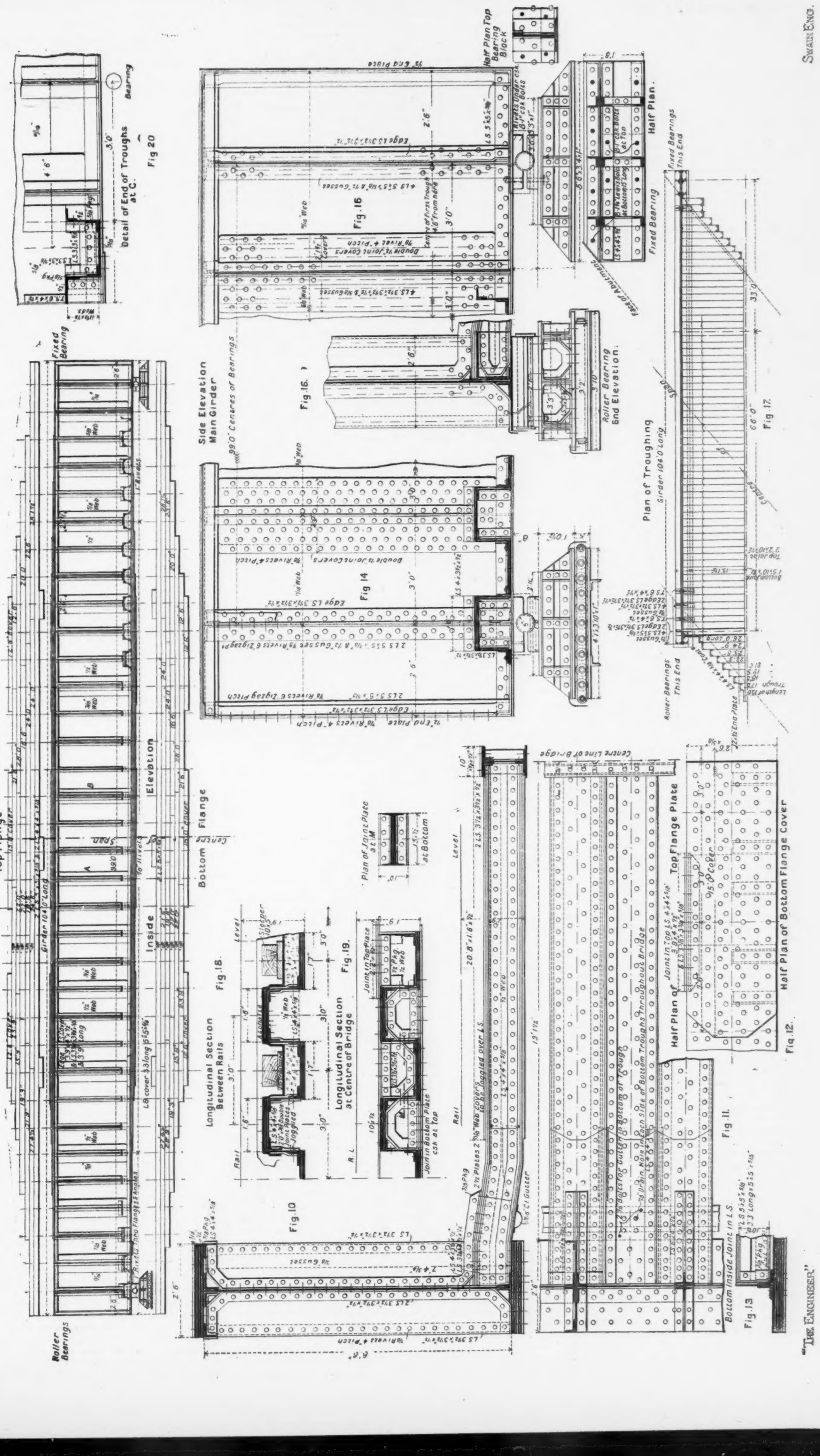
A STEEL plate girder bridge, of a span of 99ft. between the centres of the bearings, and at an angle of skew of 41½ deg., carries the line over the Leeds and Wakefield public road. The effect of this sharp angle becomes very apparent on referring to Figs. 1 and 2, which represent a plan and elevation of the bridge. It serves to convert the span on the square of 60ft., and also the length of the abutment of 33ft., into oblique dimensions of 90ft. 6½in. and 49ft. 9½in. respectively. Inside the main girders, which have each a total length of 104ft., the width on the square is 26ft. 8in., as shown in the transverse section in Fig. 3. A cross section of the abutment on the square is given in Fig. 4, and cross section of the wing walls at different heights in Figs. 5—8. The foundations consist of a solid mass of concrete 6ft. in thickness, carried, in the case of the abutments, to the maximum depth of 17ft. 6in. below the original ground line. A slope of 1½ to 1, and a good stiff batter of 1 in 8, distinguish the wing walls, which are coped with blue Stafford bricks, while the caps of the parapet newels are 7ft. by 4ft. by 2ft., and of dressed ashlar work. It is to be noticed that in both the abutments and wing walls, offsets at the backs of the walls are dispensed with, and the thickness remains constant for nearly the whole height of the walls. An elevation of one of the main girders is represented in Fig. 9. It has a depth at the centre of 9ft. 3in. over all, and at the ends of 8ft. 6in., where there is only one horizontal flange plate, and the ordinary longitudinal angle steels connecting the flanges and the web. At the centre of the main girders, the upper flange, which, similarly to the lower, is 2ft. 6in. in width, is built up of three horizontal plates ⅝in. in thickness and two of ½in.; and a pair of angle steels 5in. by 5in. by ⅝in., and an additional pair 4in. by 4in. by ⅝in. riveted to the under side of the flange plates, as shown in the cross section in Fig. 10. In the lower flange this pair of angle steels is omitted, and all the five horizontal plates are ⅝in. in thickness. At the middle of the girder the thickness of the web is ⅜in., increasing towards the abutments to ½in. and ⅝in., and over the bearings to 1⅛in. At regular intervals of 3ft. along the elevation, the web is stiffened alternately by stiffeners composed of four vertical angle steels 3½in. by 3½in. by ½in., and ⅝in. gussets, and two steel ties 6in. by 4in. by ½in. Double covers ⅝in. and ½in. thick connect the joints of the web, and are secured to it by rivets ⅞in. in diameter, with a pitch of 4in. Full details of the manner in which the whole of this construction has been executed are given to an enlarged scale in the working drawings in Figs. 10 and 14 to 16. Both girders rest in the first instance at each end upon a steel pin 5in. in diameter, which is carried by hollow built-up steel bed blocks 1ft. in height, shown in Figs. 14, 15, and 16, page 641. At the fixed end these blocks are bolted down, and at the other end they bear upon a nest of steel rollers. Owing to the fact that there is a depth of only 1ft. 9in. from rail level to the soffit of both the main and cross girders, available for constructing the platform of the bridge, it became necessary to adopt an especially heavy type of trough flooring, which is represented in Fig. 17 in plan, and, as will be seen, dispenses with the employment of all cross girders. As it is unavoidably rather complicated in its construction, it will be as well to describe it a little more particularly. Referring to the transverse section in Fig. 10, an elevation of the trough, which, it must be admitted, has very much the appearance of an ordinary cross girder, is shown, together with a cross section of the stiffening longitudinal girder at the centre of the track, which will be further alluded to. In Fig. 18 there is a longitudinal section between rails of the trough, which very well displays the manner in which it is built up. It consists essentially of three alternate upper and lower flange plates, 1ft. 6in. and 1ft. 7in. respectively in breadth, and varying in thickness from ½in. to ⅝in., united by angle steels to plate webs, ½in. thick throughout their whole length. The transverse timber sleepers supporting the metals are laid in the troughs, and are also bedded upon a mass of concrete resting upon the lower flanges of the alternate troughs, the intermediate spaces between the sleepers and the metallic sides of the trough being flushed up with asphalt. A longitudinal section at the centre of the bridge in Fig. 19, combined with Figs. 10 and 11, which latter is a plan of the former, illustrates one manner in which the central stiffening girder is riveted in between the inverted troughs, and also how the outside horizontal plates of both the upper and lower flanges pass respectively above and below the outside plates of the flanges of the troughs to which they are riveted, as shown in the working drawings. One of the photographs in connection with the Leeds and Wakefield road bridge given last week represents a main girder completely constructed and securely loaded upon railway trucks at Darlington, waiting conveyance to its permanent site. The other photograph shows both girders hoisted up or lowered down, as the case might have been, into position, and nearly ready for the adequate performance of their duty. We have reserved for our concluding article the description and illustration of the great swing bridge over the river Aire at Thwaite Locks, which surpasses in the length of its maximum span any similar structure yet erected.



HUNSLET RAILWAY—WAKEFIELD ROAD BRIDGE

HUNSLET RAILWAY—WAKEFIELD ROAD BRIDGE

(For description see page 640)



"THE ENGINEER"

LITERATURE.

A Treatise on Masonry Construction. By IRA O. BAKER, C.E., Professor of Civil Engineering, University of Illinois. Ninth Edition, revised and partially re-written. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1899.

UNDER the general and comprehensive title of the volume before us are included a discussion of the subjects relating to the employment of brick and stone, both natural and artificial, and of mortar, cement, and concrete, by the engineer and architect, in the construction of buildings of various and manifold descriptions. They comprise, among other examples, masonry dams, retaining walls, bridge piers and abutments, and culverts and arches. A completely new short chapter, IIIA, upon "Sand, Gravel, and Broken Stone," has been added with advantage to this edition, wherein sharpness, cleanness, proper size of grains, and comparative coarseness, are strongly insisted upon in a material which constitutes so important an ingredient in the preparation of mortar and concrete. It is difficult to find in engineering text-books a precise or definite specification of a "clean" sand. One states that "clean sand should leave no stain when rubbed between moistened hands," and the author observes that for the bridge work on the New York Central and Hudson River Railway, the specification required "that the sand shall be so clean as not to soil white paper when rubbed on it." Another definition very similar to that just quoted is that "perfectly sharp clean sand will not soil a white kid glove." As a general rule a coarser kind of sand makes the stronger mortar, and the smaller the interstices between the grains of sand the less the amount of cement required, and the more economical the mortar. This chapter gives the results of a very scientific and careful study made by the author of a large number of sands which have been recorded in some valuable tables, showing the effect of different descriptions of sand upon the strength of mortar. By additional investigations, the voids and weight of a large variety of sand, gravel, and broken stone have been also determined, and the influence they exert with respect to the strength and economy of both mortar and concrete.

The second part of the work, dealing with "Preparing and Using the Materials," commences with Chapter IV., with the subjects, "Mortar, Concrete, and Artificial Stone," and has been re-written and nearly doubled in extent. The various methods of preparing and proportioning mortar are discussed, and tables are given of the different quantities of sand and cement required for a cubic yard of mortar in which the ingredients vary in amount. Some useful diagrams are appended, showing the effect of time upon the strength of mortars, and their tensile and adhesive strengths respectively. It must be admitted that hitherto experiments having for their object the determination of the compressive as well as of the adhesive strength of mortar have been both few and far between, and the following information is therefore of value:—"An examination of the results of about sixty experiments made with the Watertown testing machine seems to show that the compressive strength of mortar, as determined by testing cubes, is from eight to ten times the tensile strength of the same mortar at the same age. This ratio increases with the age of the mortar and with the proportion of sand." At the same time it is admitted that the results obtained by subjecting cubes of mortar to a stress of compression are practically of little or no value as indicators of what the strength might be when the material assumes the form and consistency of a thin layer, as occurs in the joints of masonry and brickwork. This is but another example of the discrepancy that has been proved to prevail between the relative strength of test samples or specimens of different materials, and the strength of the same materials when of proportions and dimensions, and under conditions widely varying from those employed in the experiments from which their actual resistance is supposed to be derived.

The remainder of Part II. is occupied by chapters upon quarrying, stone cutting, and stone and brick masonry, which, perhaps, pertain more to the province of the general builder and building contractor than to the engineer. In summing up the respective merits of brick and stone masonry, the author appears to consider that brick is rather hardly treated, and in this opinion there is no doubt considerable truth. A general idea has got about that in some way or other brickwork is inferior to stone masonry, and in certain respects it is, and will always remain in that subordinate capacity. Brick, in localities in which stone is handy and plentiful, has no chance with the more solid and massive stone, as witness our numerous granite cities, and structures of stone work abroad. Part III. treats of foundations. Mr. Baker divides them into ordinary, pile, and foundations under water. The first class includes briefly the foundations for any structure founded upon dry or nearly dry ground. Among the principal points to be attended to are the methods of examining the site, to determine the nature of the soil, the relative bearing powers of different soils, and the means to be adopted for increasing the bearing power when Nature has not supplied the necessary amount of resistance. The designing of the footings, and the manner of increasing the area of the foundation, are well and clearly explained, and a formula is given for ascertaining the offsets for each footing course when the thickness or depth is known. Under the second category are comprised pile foundations, and Chapter XI. describes the different kinds of piles, the methods of driving them, and the nature of the power employed. Several excellent examples of engineering works actually constructed show the supporting power of piles, and their ultimate and safe loads, which accord to the factor of safety the fairly wide margin ranging from two to twelve. Foundations under water form a class by themselves, and include the cofferdam, the crib and open caisson, the pneumatic and the freezing processes, together with all the smaller systems connected with them. The reader must consult this chapter for himself, which he can do to his advantage, as we have not space to further enter into its contents.

Masonry dams are classified under two heads, those which resist the pressure of the water by the inertia of the masonry, and those which resist it by virtually transferring it to the two extremities, on the principle of the arch. The first is termed a gravity, and the latter an arched dam; but as only two of the latter have ever been built, we may restrict our attention to examples of the former type. It is quite possible for a dam to combine in itself the two principles of both the arch and gravity types, and for the section to be so proportioned that half the stability will be due to the action of the arch and half to that of gravity. The different formulæ relating to the stability of masonry dams and the conditions of equilibrium are fully investigated for each particular force tending to overturn them, and the author arrives at the conclusion that "were it not for the incompleteness of our knowledge of the laws governing the stability of masonry arches, the arch dam would be the best type form, since it requires less masonry for any particular case than the pure gravity form," and in this opinion he is no doubt correct, judging from the proportions of the two existing examples of this type.

There is probably no subject connected with construction which has received more attention from the mathematician, the professor, the scientific lecturer, and the engineer than that of retaining walls. After quoting the best-known theories and formulas respecting the stability of retaining walls, which are those of Weyrauch, Mosely, Coulomb, and Rankine, the author proceeds to analyse them, or, it may be truly said, to demolish them. He observes that "theoretical investigations are but of little value in designing retaining walls, that the problem of the retaining wall is not one that admits of an exact mathematical solution, and the conditions cannot be expressed in algebraic formulas." While we are not prepared to fully endorse these statements, there is no doubt much force in some of them. For instance, Mr. Baker states: "Bear in mind that none of the above formulas apply if the back of the wall inclines towards the earth to be supported, or if the wall has a curved profile, or if the upper surface is irregular, and as in these cases the surface of rupture is not a plane, hence no theory yet proposed will apply." It is perfectly well known that the most stable earth, after being exposed for some time to climatic and atmospherical influences, will give way, and form for itself an inclined or sloping surface. Now, this is not a plain surface, but a curved one, concave towards the face or front, of which the upper part remains in a nearly vertical position, and the lower gradually flattens out towards the ground line at the bottom. The author also addresses a word of warning to students, by reminding them that "not all theories for retaining walls are as nearly correct as those referred to," but that, on the contrary, "some of them, although having all the prestige of antiquity and offering the advantages of extended tables for their application, are totally valueless, being based upon unwarranted assumptions and violating the fundamental principles of mechanics." The reference to Rankine's theory at page 348, appears to take for granted that it is therein assumed that "the thrust of the earth makes an angle with the back of the wall equal to the angle of repose of the earth." There seems to be some mistake here. Rankine assumes that "the thrust of the earth is parallel to the surface slope of the ground," and the professor also assumes in this general formula that the back of the wall "inclines towards the earth to be supported," which last hypothesis, according to Mr. Baker, puts him entirely out of court. We are of opinion that Rankine's theory and formulas must stand, and we accordingly exempt them from the denunciation of the author. Towards the end of the chapter empirical rules are given which will suffice to determine for all practical purposes the great desideratum, that is the thickness of the wall. The rules laid down more than half a century ago, and in accordance with which hundreds of retaining walls have been successfully built and maintained, have been endorsed by "the eminent English engineer Sir Benjamin Baker," who states that "experience has shown that a wall sustaining earth having a level surface, whose thickness is one-fourth of its height, and which batters one or two inches per foot on the face, possesses sufficient stability when the backing and foundation are both favourable." Summing up, the usually adopted rule of making the thickness of retaining walls equal to one-third of the height from the top of the footings, appears to meet with general acceptance.

As with arches of iron, so also with those of masonry, the proper function of the spandrel bracing of the one, and the spandrel walls of the other, is very much a matter of conjecture. Hence the author states that if the arch is surmounted by a masonry wall, as is frequently the case, it is impossible to determine, with any degree of accuracy, the effect of the spandrel walls upon the stability of the arch, though at the same time he admits that the error in the usual assumption that the entire weight of the masonry above the arch presses upon it, is certainly on the safe side. The various theories—and their number is considerable—put forward to attempt to solve the arch problem are fully and ably discussed, including that of Rankine, which "is in some respects much superior to the one in common use, but is comparatively but little employed in practice." Mr. Baker charges the professor with taking no cognisance of the horizontal components of the external forces, whereas Rankine does recognise them, but does not consider it a wise proceeding to rigidly connect the voussoirs of the arch to solid masonry superimposed upon it, and carried directly by it, although the extent of the support it may receive from it is unknown. "A Treatise on Masonry Construction" is both theoretical and practical, and the author may be credited with having the courage to maintain his opinions, even when adverse to those of well-known authorities, which he has expressed in the previous editions of his work, of which the present is a worthy and valuable successor.

A Treatise on Surveying. Compiled by REGINALD E. MIDDLETON, M. Inst. C.E., M. Inst. Mech. E., F.S.I., and OSBERT CHADWICK, M. Inst. C.E., M. Inst. Mech. E., C.M.G. In two parts. Part I. London: E. and F. N. Spon, Limited, 125, Strand. New York: Spon and Chamberlain, 12, Cortlandt-street. 1899.

THE authors very modestly term their work a "compilation," as, in fact, all books must be to some extent which treat of any subject which can boast of a title possessing the antiquity that "Surveying" does; but we think its contents have a far wider and more useful range than that claimed for it. There is no doubt that the introduction of the Ordnance Survey and the publication of the Ordnance maps to various scales practically destroyed the business or occupation—for it can hardly be called a profession—of the old type of surveyor, or measurer, as he was frequently styled. The knowledge of surveying acquired by this class of men was, as a rule, strictly limited to that of "chain surveying," as fully described in the first chapter of the volume before us. They did not as a body aspire to the use of the level, the theodolite, or other instruments, and some of the implements indispensable to their work were of a very rude and primitive description. We have more than once seen a smooth oblong stone, fastened in some mysterious manner to a string, spliced and knotted in several pieces, do very satisfactory service as a substitute for the steel or brass plumb-bob, and yet, notwithstanding all drawbacks, the work was well and truly done, sufficiently accurate, at any rate, for ordinary railway surveys in the open country. A knowledge of surveying, both theoretical and practical, upon the lines laid down in the book under notice, is essentially and necessarily a part of the professional education of every civil engineer, and the more elementary stages of it can readily be picked up in the field, at a comparatively very youthful age.

In Chapter III. the "Description and Adjustment of Instruments" is discussed, from the humble optical square to the finished transit theodolite, and is a subject which is invariably fraught with great interest to the reader. The optical square is an improvement upon the old wooden cross staff, and we do not quite see the necessity that it "should be capable of adjustment by means of a screw which will slightly turn one of the mirrors." As both reflecting mirrors are fast fixed by the maker at an angle of 45 deg., they will remain so, unless the instrument is subjected to bad usage, in which case the mischief could not be repaired by any adjusting screws. Instead of the optical square, a box sextant set to a right angle will answer equally well, and is quite as portable, although a trifle larger. The improvements adopted recently by makers in the pattern for levels are alluded to. The great object in view is of a two-fold character, and comprises the reduction of the number of separate parts, and such an arrangement of those parts themselves as will permit of a combination of the solidity and compactness of the dumpy with the accuracy and convenience of the adjustment possessed by the Y pattern. We have used levels constructed upon this combined system, and found them to give excellent results, although their weight for the same focal length is greater than that of the dumpy. This follows from the fact that the longitudinal bubble tube must be rotated in adjusting the collimations as part and parcel of the telescope, and that consequently it is impossible to reduce the stout Y supports below a certain minimum, though they are greatly shorn of the preposterous dimensions originally assigned to them. As no mention is ever made in modern treatises and text-books on the subject of levelling, nor any specimen displayed in the shops of the instrument makers of the "Troughton" level, so named from the well-known maker, it has evidently become obsolete. Yet it unquestionably had its advantages, of which the chief one was that the long bubble tube was fixed permanently in the upper part of the telescope by the maker parallel to the axis of the telescope, and therefore dispensed with all those adjustments between tube and telescope required in the other patterns, besides rendering the instrument more compact, lighter, and self-contained. The objection to it was that in the event of the bubble tube being broken, it could only be replaced by the maker, and the statement certainly has considerable force. As a matter of principle, the combination of the Troughton and the Y types would constitute a perfect instrument. It may be mentioned here that Gravatt's, as well as other methods put forward in some treatises for adjusting the collimation of a dumpy, are useless. Unless there are some means by which the diaphragm carrying the cross hairs or wires can be rotated, accurate and satisfactory rectification of the line of collimation is not possible. Both the Y, that is, the old "cradle" theodolite, and Everest's theodolite have given place to the modern transit, even in India, where Everest's at one time was supreme.

The reader will find Chapter IV., on "Traverse Surveying," well worth perusal, in which the advantage of the method of plotting by co-ordinates, especially when the survey is of large extent, over that of drawing polygons on paper by the aid of scale and protractor, is clearly explained. It is pointed out in discussing the "whole circle," and the "four quadrant" or "reduced bearing" notation, that the surveyor deals with angles and trigonometrical functions in a manner somewhat different to that in which they are discussed in treatises relating to trigonometry. In these latter the angles and trigonometrical functions are taken round from right to left—that is, in the direction opposite to that of the hands of a watch. But in surveying they are assumed to be measured from zero to 360 deg., beginning at the top or north of the circle in the direction of the hands of a watch, and it is after this fashion that the graduation of modern theo-

dolites is arranged. It is scarcely necessary to remark that the value of the sines, cosines, and other trigonometrical functions do not alter. It is difficult to pronounce upon the relative merits of the two systems. The four-quadrant system dispenses with a large amount of clerical labour attached to the "whole-circle method;" but, on the other hand, errors are more likely to occur in its use than in that of the other. It must be borne in mind that in the division of surveying into chain, traverse, and triangulation methods, they are distinguished as follows:—In the first the location of the various points is ascertained by linear measurement alone; in the second they are determined by one lineal and one angular measurement; and in the third by only one lineal measurement, and that is of the base line, and it is by the process of the triangulation that the relative distances between the points or stations are obtained and the calculation of their co-ordinates made. Some sound advice and valuable practical hints are given in the chapter on "Minor Triangulation," under the heading of "Method of Conducting a Triangulation," embracing the selection of stations, suitable sizes of triangles, observation signals, and other cognate subjects. Of the two ordinary methods of observing angles, by which more correct values can be obtained than is possible by a single reading, the authors prefer "reiteration" to the old method introduced by Borda under the title of "Repetition," and we refer the reader to the reasons given for the preference. It is just possible, however, that if, instead of a "small and inferior instrument," a fairly large and superior transit theodolite were used, the discrepancies might be to some extent diminished. As might be expected, Messrs. Middleton and Chadwick endorse the opinion held by all engineers and surveyors by remarking that in determining relative heights by means of vertical angles, "the degree of accuracy will not be equal to that of good levelling."

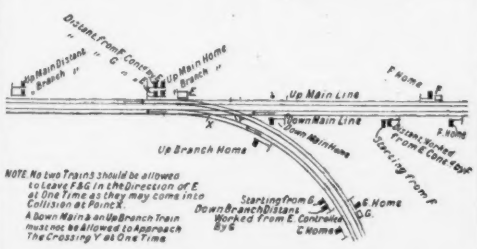
The plane table and the method of using it is also explained. This method of surveying is very little, it it might be said scarcely at all used, in England, where it is considered as possessing but very poor claims to even comparative accuracy, and only suitable for topographical work on a small scale. But by attaching a telemeter or tacheometric telescope to the table, and a few other appliances, the whole forms an instrument of considerable precision, and can be employed successfully in more extensive surveys, when a base line has been carefully measured. The plane table is used a good deal on the Continent, and also in tropical countries. The survey of Switzerland in connection with a measured base, the tracing of the St. Gothard and Simplon railways, and the filling in of the details of the town survey of Hongkong, are examples in which this method has been advantageously put in operation. A chapter on levelling and contouring brings to a close a volume of which it may be truly said that it contains all the information necessary to enable the student and beginner to acquire the knowledge demanded of a fully-qualified surveyor. Working examples of field books and of plotted surveys are interspersed with the text to assist the reader in his study of the contents.

Analyse Microchimique et Spectroscopique, par M. E. Pozzi-Escot. Small 8vo., pp. 192, with forty figures. Paris: Gauthier Villars and Masson and Co.

THE use of the microscope for the examination of the crystalline structure of precipitates obtained in chemical analysis, although now more general than formerly, is still sufficiently restricted to make this little volume a welcome addition to the working library of the analytical chemist. Without being entirely new, as the subject has been studied by several earlier observers, notably by Streng, Boricky, Behrens, and Rosenbusch, whose works receive due mention in the introductory chapter, there is much of considerable interest in the volume, which contains, in addition to a rapid historical sketch, descriptions of the apparatus and reagents required, of the methods of working, and a systematic account of the reactions characteristic of the principal elements. This latter part contains several drawings of characteristic crystalline compounds obtained by microchemical methods, and several new reactions are described. We note, however, with satisfaction that the observer is recommended to produce typical slides for himself as standards of comparison for his results rather than to trust to published drawings, however good they may be. Another useful recommendation is that of avoiding the use of high magnifying powers, a maximum amplification of 200 to 300 diameters being regarded as most desirable, higher powers being not only useless, but prejudicial to the clear observation of the reactions. Schemes for the systematic application of the tests, so far as they can be given in the present somewhat rudimentary state of the methods, are given in the third chapter, and in the fourth special applications to the analysis of water, the examination of minerals for precious metals and rare elements, and the composition of alloys. The fifth chapter is devoted to the microchemical examination of rocks, and contains many useful hints upon the rapid determination of the constituents of crystalline rocks. The second part of the volume, entitled "Spectroscopic Analysis," contains, besides an introduction, a very generalised sketch of the construction of spectroscopes, the nature of luminous and absorption spectra, the determination of wave lengths, and the methods of producing metallic spectra; but as the whole of these matters only covers about twenty pages it may be readily understood that they do not convey much practical information. In fact, it would be somewhat of a puzzle to know why they have been included here, were it not for the circumstance that in the introduction on page 166 we are told that they are to be considered as a preface to two previously published volumes by another writer on "Spectroscopy and Spectrometry" in the same series to which the reader "who wishes to initiate himself more profoundly in the science" is referred. This seems to be a scarcely permissible mystification on the part of the author, who might more usefully have devoted the space to a further elucidation of his own subject.

RAILWAY SIGNALLING IN AMERICA.

THREE interesting papers have lately appeared in the United States on the subject of railway signalling in that country. These were read before the annual meeting of the American Railway Signalling Club. The first of these, which we propose to notice, was by Mr. H. M. Sperry, of the Union Switch and Signal Company, and its title is "Progress in Signalling." The author states that in the United States a green light is nearly universally acknowledged to be the proper colour for indicating that the line is clear, but that opinions differ as to the colour which should be used for distant signals. The New York, New Haven, and Hartford Railroad authorities have made a strong effort to establish yellow as the proper colour for distant signal lights. A serious accident on this line in 1898 caused the adoption of a green light for "all clear," red for stop, and yellow for caution. The Massachusetts Railway Commissioners, in their report for 1899, refer largely to the use of colours for night signals. An instance is here quoted of an accident occurring in consequence of a driver having mistaken the white lantern on a crossing gate for a clear home signal. We are told that "the usual colours for railroad signals, which, until recently, have been almost universally adopted in all civilized countries, are the following:—White to signify safety, red to signify danger, and green to signify caution." This was formerly the case on most British lines, having been agreed to by a congress of railway men held in Birmingham in 1841. In America the three lights seem to have been extensively used until quite recently. We are reminded of the experiments in France of the brothers Chappe, who found that the visibility of a red light is but one-third of that of a white light of the same intensity, that of a green light one-fifth, and that of a blue light one-seventh. White was chosen as the signal for safety, as being the usual light as well as the most easily visible, while red as the most easily visible of the coloured signals was chosen to represent danger. So far as visibility was concerned, it would have been desirable to have white for the danger signal, but "it was, of course, impracticable to use white" for this purpose. The reason of this is not stated, perhaps because the serious objections to the use of a white light for a safety signal are evident. The "permissive block" system, so widely used in the United States, is not allowed in this country, so that a cautionary signal is not considered necessary, and the distant signal is simply a duplication of the home signal. The objections to white as a safety colour are, of course, very well known. The first is that, should the red of the danger signal become broken the light shown would be white, and the driver would imagine the line clear, whereas it might be obstructed. The second reason is that the signal light itself may become extinguished, and the driver may take any other white light for the "clear" signal. In spite of these, however, the majority of the American railroads still use this colour. The arguments used against giving it up are as follows:—First, the drivers are accustomed to it, and any change might be dangerous, since a white light not on the line might be taken as a safety signal from force of habit. Then, too, principally on account of the "permissive block" system, it is necessary to have a signal for caution, and it appears difficult to find a suitable colour for this purpose. Blue is unsuitable on account of its slight visibility, particularly since the light from an ordinary lamp emits but few blue or violet rays. Amber and orange have been suggested, but are objectionable as being so easily confused with red, if the tint be dark, or with white, if the tint be light. This difficulty has been met on some railroads by using as a cautionary signal a red and green light or a combination of green lights. No general agreement has, however, been come to. In 1894 the Committee of the American Railway Association on interlocking and block signals recommended red for danger, violet for caution, and green for safety. This opinion was reversed within a month, and the Committee recommended, though not unanimously, the continuance of green for caution and white for safety. The association then definitely voted against giving up white as a safety signal. Later in the same year the Committee reported that the use of blue and orange lights did not appear practicable, but that a combination of red and green could be used for caution. In March, 1895, the Committee went so far as to pass the following resolutions:—"That the Committee does not at this time deem it wise to recommend abandoning white for a night signal; as, first, three indications are necessary in many cases, and, secondly, no entirely satisfactory single colour has been found for a third indication. The Committee approves, however,


Up Main Home
Up Main Line
Down Main Line
Up Branch Home
F Home
E Home
C Home
C.G.
NOTE. No two Trains should be allowed to Leave F & G in the Direction of E. at One Time as they may come into Collision at Point X.
A Down Main & an Up Branch Train must not be Allowed to Approach The Crossing Y at One Time

the use of red for danger—stop, and green for clear—proceed, as good signal practice." In the standard rules for block and interlocking signals, adopted in the same year, the association decided on red for a danger signal, but left blank the colours for safety and cautionary signals, allowing each company to decide this for itself. In the standard train rules, adopted in 1898, the same course was followed. The opinion seems to be gaining ground, therefore, that white should be abandoned as a signal colour.

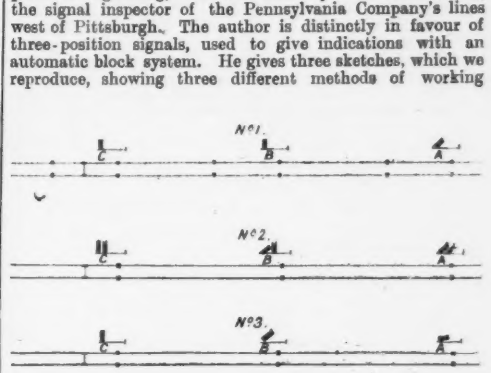
This paper also deals with junction block working. The author thinks this should be always adopted and strictly carried out. No two trains should ever be allowed to approach a junction at one and the same time, either upon converging or crossing lines, otherwise the required certain interval of space is actually reduced to nothing more than the thickness of the junction signal post. In the above diagram the arrangement of the signals is in accordance with English practice—the arm pointing to the left and the "spread system" used for the diverging route, that is, two posts placed side by side, the left-hand post covering the "up main," or left-hand route, the right-hand post covering the right-hand route, or "up branch." We are told that it would be very awkward to carry out this system on American lines, especially on those that are without block signals.

The remaining portion of this paper is devoted more or less entirely to the actual mechanical working of the signals, and possesses no special point of interest to the English reader.

The second paper, by Mr. A. J. Wilson, of the Hall Signal Company, deals with automatic signals—"Normal Safety as against Normal Danger." We are told that automatic signals have been in use in the United States, to a greater or less extent, for nearly thirty years. The first application was on the Eastern Railroad and the New York and Harlem Railroad in 1871. This system was worked on the open-circuit plan, but to guard against the possibility of a signal failing to show danger on account of a broken wire, or other derangement of the apparatus, two signals were used. At the entrance to each "block" was placed a home signal, and a caution, or, as it was called, a safety signal, about 500ft. in advance of the home signal. The normal position of the home signal was "clear," and of the safety signal "caution." When a train passed the home signal, putting it in the "danger" position, another circuit was completed, clearing the safety signal, thereby showing the driver that the system was in operation, and that he was protected in the rear. The system was also used on other railways. Some time after it had been introduced, the circuits were changed so as to work the signals on a closed circuit, and the safety signal was done away with. All automatic signals were, until 1891, worked on the "normal clear" principle. Current was being taken continuously from the batteries, except when the block was occupied. Hence, on this system, there is necessarily a large waste of material. On the "normal danger" system, however, the battery is only in use when the signal is clear for an approaching train. On one railroad starting from Boston there are a number of signals worked in both these ways, and from these the writer of the paper draws an interesting comparison as to the relative cost of each. On the "normal clear" system it appears that the batteries have to be renewed every eight to ten weeks, while on the "normal danger" system the renewals, with practically the same service, need only be carried out every six to eight months. Without following right through the details by which the figure is arrived at, we may say that, using 1000 cells, the author calculates that, by changing to the "normal danger" system, there would be a yearly saving of some £320, and this takes no account of labour; whereas it is evident that, on the "normal danger" plan, one man could look after a larger number of batteries.

What are the objections, then, to the "normal danger" system, and do they justify its being discarded, especially having regard to its relative cheapness? It is claimed that it is more expensive to construct; that there are more chances for trouble; that it is more difficult to maintain, and that certain combinations could occur which might prevent a danger signal from being shown with a train on the block. Against these the author allows that the signals on the "normal danger" plan will cost some £5 more to construct; but inasmuch as there are fifteen cells to each signal, and as each cell can be worked by this system at a saving of 6s. 4d. per annum over the cells working a "normal clear" system, the extra cost is practically wiped off in the first year. Then, as regards complication, there is an extra contact, it is true, but statistics show a working record in favour of "normal danger" signals.

The third paper deals with "The Possibilities of Three-position Signalling," and was read by Mr. Frank Rhea, the signal inspector of the Pennsylvania Company's lines west of Pittsburgh. The author is distinctly in favour of three-position signals, used to give indications with an automatic block system. He gives three sketches, which we reproduce, showing three different methods of working



signals. No. 1 is the "overlap system," and consists simply of single home semaphores; No. 2 is the home-and-distant signal system; and No. 3 is the proposed three-position signal system. Here there is only one home signal for each block. The author describes the action of this as follows:—The train entering block A throws signal A to danger position. The train entering block B throws signal B to the danger position, and when the rear of the train has cleared block A, signal A assumes the middle or caution position—showing a green light at night—indicating that block A is clear, but that home signal B is in the danger position. The train entering block C throws signal C to the danger position, and when the rear of the train has cleared block B, signal B assumes the middle or caution position—showing a green light at night—and signal A assumes the clear position, indicating that block A is clear, and that signal B is either in the caution or clear position; thus giving, he adds, the completeness of information that is given by the home-and-distant signal system, but requiring the reading of but one signal only at a time, for this completeness of information.

The merits of the three systems are then discussed. It is generally admitted that the overlap system has not proved satisfactory. The speed of trains has either to be reduced or, if it is not, then all the benefits possible to be obtained from a system of automatic signals are not derived. There is no advance indication of the condition of the next block forward. There may be a clear signal at one block and an absolute stop at the next block. The "home-and-distant" and the "three-position" signals give the same completeness of information; but the author says:—"I think it will be

readily admitted that the three-position system gives its indications more simply and to the point, and that it is easier for the train men to read and interpret these indications quickly." From the economical standpoint, too, it has the advantage. As to maintenance, it is probably the cheapest of the three. There is only one signal to each post instead of two, and each lamp costs something like £3 per year in oil and attendance.

REPORT OF THE LIVERPOOL SELF-PROPELLED TRAFFIC ASSOCIATION.

IN our last issue we gave a brief account of the "At Homs" held on the 19th inst. by the Liverpool Self-propelled Traffic Association, and a short *résumé* of the speeches made on that occasion. The awards were also presented to the successful competitors in the heavy traffic vehicle trials held in the beginning of last August. The Association has published the results of these trials in book form.

The volume is very similar in arrangement to that issued last year, and commented upon in vol. lxxxvi., page 540. Very complete arrangements were made for carrying out the trials, which lasted from July 28th to August 2nd, the first two days being devoted to the weighing and measuring of the vehicles and their inspection by the judges. The difficulty of obtaining a car to carry from 3 to 4 tons, and to have a tare within the legal limit of 3 tons, will be seen from the tables, as three of the cars, weighed perfectly empty, with tools removed, gear cases taken off, and gears scraped, were over 2 tons 19 cwt. each.

For a description of the cars themselves we must refer our readers to our issue of August 4th, 1899. A few particulars not then available are given in Table I. The cars which competed were classed as follows:—

Class A.—Minimum load, 2 tons; maximum tare, 2 tons; minimum level platform area, 50 square feet.

Official No. III.—G. Coulthard and Co., of Preston. This car, however, was disqualified, as its tare was found to be in excess of the maximum for the class, being 2·238 tons. The car, however, was allowed to run, although it only went out two days.

Class B.—Minimum load, 3½ tons; maximum tare, 3 tons; minimum level platform area, 65 square feet.

Official No. I.—The Steam Carriage and Wagon Company, Limited, of Chiswick; Thornycroft's system.

Official No. V.—The Lancashire Steam Motor Company, of Leyland.

Official No. VI.—The Clarkson and Capel Steam Car Syndicate, of Deverell-street, London.

Official No. IX.—Bayley's Limited, of Newington Causeway, London.

Class D.—Minimum load, 6½ tons; maximum tare, 4 tons; minimum level platform area, 110 square feet.

Official No. II.—The Steam Carriage and Wagon Company, Limited, of Chiswick; Thornycroft's system; car and trailer.

In Class C., minimum load, 5 tons; maximum tare, 3 tons; minimum level platform area, 80 square feet, there were no competitors, the single firm entering this class evidently realising that the task of carrying 5 tons on Lancashire roads was too much, when bound down to a maximum tare of 3 tons.

The first day of the trials proper, July 31st, was devoted to hill-climbing tests, which were, we believe, the first of their kind carried out with this class of motor car in this country. Liverpool is peculiarly well situated for obtaining stiff gradients with a variety of surfaces within a short distance. A length, consisting of Everton Brow, Browside, and Rupert-street, was chosen, which included macadam, boulders, Lancashire grit sets, and smooth granite sett pavement, with gradients varying from 1 in 17 to 1 in 9½.

The cars had to run up and down these gradients, making an emergency stop on the 1 in 9½ smooth granite sett pavement. With one exception they performed the trial satisfactorily, although there were several cases of slipping, and these mostly occurred when running light, when the weight on the rear or driving axles was very small. It was of interest to note that, with the exception of two empty cabs, no horse-drawn vehicles were seen going either up or down the steeper portion of the route, Everton Brow, during the whole of the day.

Some little difficulty was experienced with one or two of the cars in starting from rest on the steepest gradient on the up journey, whilst coming down several of the cars travelled twenty or thirty yards after the signal to stop had been given, although some stops were made in 3ft. or 4ft. This distance, however, to some extent depended upon the speed, and it was found impossible to get a uniform velocity with the various vehicles and drivers.

Manœuvring tests were carried out by requiring the drivers to lay the cars up against a wall which formed the side of an embayment one and a-half times the lengthof the car. Work of this description must always depend to a great extent upon the individual skill of the driver, but, in most cases, we note that the vehicle was laid sufficiently close for loading purposes. We would, however, point out that this is a manœuvre which is rarely, if ever, required in practice, as a lurry usually backs right on, or has sufficient room to draw up in a far greater distance than one and a-half times its length.

August 1st and 2nd were devoted to road runs similar to those carried out last year, namely, of about 36 miles each day, the first being *viâ* Prescot, Santrey, and Widnes, over a fair surface, whilst the second day was *viâ* Ormskirk, Rainford, and the Hazels, when some very rough stretches of boulders and setts were met with. The most noteworthy feature of the runs was the absence of the serious breakdowns which were so discouraging in the trials held last year.

TABLE I.—*Summary of Particulars of Vehicles.*

Vehicle.	Tare. Empty, tons.	Tare. Fully provisioned, tons.	Capacity of water tank, gals.	Capacity of oil tank, gals.	Capacity of bunkers, cwt.	Available platform area, sq. ft.	Boiler. Heating surface, sq ft.	Boiler. Declared working pressure, lb. per sq in.	Engine. Cylinders, diameter, inches.	Engine. Stroke, inches.	Engine. Revolutions per minute at full speed.	Engine. Declared brake horse-power.
Thornycroft .. .. No. I. ..	2·996	3·8.2	114	—	3·0	65·0	83	175	4 and 7	5	770	35
,, ... No. II.	3·167	4·330	160	—	5·75	67·7	83	200	4 and 7	5	770	40
,, ... No. II.	0·737	0·737				57·5						
Coulthard .. .. No. III. ..	2·238	2·6 6	56	22	—	56·4	77	212	2¾, 4½, and 6	5	500	14
Leyland .. .. .. No. V. ..	2·85	3·258	50	20	—	70·8	110	200	2½ and 5	6	400	14
Clarkson and Capel No. VI. ..	2·906	3·448	49	30	—	69·7	80	200	2½ and 6	4	600	14
Bayley .. .. .. No. IX. ..	2·966	3·622	82	—	3·0	60·8	70	200	4 and 7	5	500	22

* Lower figures relate to trailing lurry.

TABLE II.—*Summary of Factors affecting the Cost per Ton-mile.*

Vehicle.	Prime cost.	Speed, miles per hour. Actual running.	Speed, miles per hour. Commercial	Load carried.	Ton-mile of load per annum of 260 working days.	Class of fuel used.	Fuel consumption. Per vehicle-mile.	Fuel consumption. Per ton-mile.	Water consumption. Per vehicle mile.	Water consumption. Per ton-mile.	Motive power per ton-mile of load.	Attendants per ton-mile of load.
	£			tons.					gals.	gals.	d.	d.
Thornycroft .. .. No. I. ..	500	5·94	5·31	3·73	48,490	Welsh coal	8·88 lb.	2·38 lb.	7·15	1 88	0·27	0·44
,, ... No. II. ..	640	6·48	5·67	6·65	86,450	,,	12·46 lb.	1·87 lb.	9·81	1·33	0·22	0·36
Coulthard .. .. No. III. ..	400	5·29	4·78	2·32	47,710	Kerosene	—	—	—	—	—	—
Leyland .. .. .. No. V. ..	450	6·17	5·02	4·41	39,160	,,	0·539 gals.	0·121 gals.	4·00	0·91	0·62	0·88
Clarkson and Capel No. VI. ..	450	5·59	4·94	3·35	57,720	,,	0·72 ,,	0·216 ,,	2·13	0·64	1·00	0 52
Bayley .. .. .. No IX. ..	600	5·54	4·93	3·67	45,550	Coke	6·76 lb.	1·84 lb.	4·65	1·27	0·13	0·65

The cost of kerosene was 5d. per gallon, of Welsh coal 20s. per ton, and of coke 11s. 6d. per ton.

TABLE III.

	Thornycroft (No. I.) Running 5·31 miles per hour.	Thornycroft (No. II.) Running 5·67 miles per hour.	Leyland (No. V.) Running 5·02 miles per hour.	Clarkson and Capel (No. IV.) Running 4·94 miles per hour.	Bayley (No. IX.) Running 4·93 miles per hour.
35 miles per day laden ..	2·56d. per net ton-mile	1·79d. per net ton-mile	2·48d. per net ton-mile	3·49d. per net ton-mile	2·85d. per net ton-mile
70 miles per day laden ..	1·98d. ,, ,,	1·40d. ,, ,,	2·00d. ,, ,,	2·92d. ,, ,,	2·17d. ,, ,,
35 miles per day laden, and 35 miles per day light	3·87d. ,, ,,	2·72d. ,, ,,	3·79d. ,, ,,	5·48d. ,, ,,	4·30d. ,, ,,

The two Thornycroft vehicles, Nos. 1 and 2—which performed throughout in a most satisfactory manner in every respect, and are two most serviceable cars for commercial purposes—went through these tests without mishap, although the trailer, which carried a load 2½ tons, evidently greater than it was designed for, was found to have hot axles upon returning to the depôt. Vehicle No. III., Coulthard, was the only one with iron wheels, which were found so unsatisfactory last year, and although it completed the first day's run, it was then withdrawn owing to trouble with the friction clutches and gear. This was to be regretted, as it would have been interesting to have seen if twelve months' improvements in iron wheels had produced an article capable of withstanding a run on cobbles and setts, such as are met with round Ormskirk. The Leyland car, No. V., which was similar, except in a few details, to the one entered last year, performed the runs without other incident than taking a wrong turning on the first day. Vehicle No. VI., Clarkson and Capel, suffered, as on the hill trials, from lack of adhesion on some of the gradients, and from the loss of a nut on the first day, and the breaking of a gland on the second. During both days the automatic feed worked very satisfactorily, and required no attention. Vehicle No. IX., Bayley's, was badly troubled the first day with hot axles of the front wheels, and although this also occurred on the second day, it caused no delay. A stop on the latter day had to be made, as the bottom of the differential gear gear-case fell off, pointing to haste in finishing the car for the trials. This vehicle emitted at various times considerable vapour. It should be noted that the trials were carried on in very fine weather, and although, from a spectator's standpoint, this is very desirable, it would be interesting to see these vehicles working under the worst climatic conditions We are doubtful whether any of them not fitted with a condenser could wholly prevent the escape of visible vapour, whilst it would be interesting to see them run on setts covered with a layer of snow, or steer on a really greasy stone surface, such as is so frequently met with in large towns. As it was, several cases of slipping and skidding occurred on the wet tram lines of the town. A summary of factors affecting the cost of per ton mile is given in Table II., and is of interest, especially if compared with that given last year in our issue of December 2nd, 1898. It will be noted that the actual running speeds were in all cases above the legal limit, although it seems that special instructions were given to the observers to keep this down. This points to the cars having an excess of power on average level roads, although none too much on the hills. The table also shows the cheapness of a solid over a liquid fuel for work of this description, although in some cases this may be partly balanced by the ease of feed and manipulation with the latter. We note that in their tender to the Chelsea Vestry for motor dust carts, the Leyland people advocate the use of coke.

Vehicles Nos. V. and VI. were fitted with condensers, which accounts for the low water consumption. This is particularly the case with vehicle No. VI., which was fitted with Clarkson's condensing tubes, and provided with a fan driven from the engine, which caused a constant current of air through the tubes. Although it is doubtless a great gain to have a condenser on long journeys where the water supply is uncertain, it has not much advantage for town work, where a regular supply of good water can usually be depended upon. No maker seems to claim for his condenser a diminution of back pressure, and they are fitted simply for water-saving purposes. A point to be noticed with the solid fuel vehicles is the performance of the De Dion boiler of the Bayley vehicle. This has been largely discussed in connection with heavy automobile vehicles, and it will be noted that, using gas coke, it only consumed 1·84 lb. per ton mile, as against 2·38 lb. of coal with the Thornycroft in the same class, whilst the water used was 12·7 lb. per ton mile, as against 18·8 lb.; it is doubtful how much of this is due to the use of highly superheated steam. It would be of interest to make comparative trials of several months' duration between these vehicles, to see if this relation would hold good after both boilers had been in use an appreciable length of time. Every care was taken at Liverpool to obtain reliable figures for the trials, the depth of fire upon the vehicles leaving and returning to the yard being noted, and allowance, if necessary, being made.

A table (III.) is given showing the cost per net ton mile, but we would point out that in the report allowance is only made for one man, and we think that 70 miles per day, at about five miles per hour, would be rather too long for an ordinary driver to keep up continuously.

In addition to the extracts given, the report is full of tables, &c., which would prove of great interest to anyone wishing to take up this form of busy work, and it and the successful carrying out of the trials reflected very great credit on Mr. E. Shrapnell Smith, the honorary organising secretary, on whom all the arrangements and the majority of the work has fallen.

NEW CARRIAGES OF THE DUTCH CENTRAL RAILWAY COMPANY.

As the number of travellers on the line from Utrecht to Baarn was continually increasing, the Dutch Central Railway Company decided some time ago to have more carriages built. Like the carriages already in use, these have been built of Djati teakwood from the Dutch possessions. The length of the carriage body is, for the second-class, 46ft. 10in.; for the third-class, 46ft. 2in., the breadth being 10ft. 1in. for both. The whole length measured from one buffer head to the other is 57ft. 3in. second-class and 56ft. 8in. third class. The carriages are lighted with gas on the Pintsch system. The provision for warming the coaches differs from that formerly in use, in that two handles have been placed on the balcony, by means of which the heating can be regulated to take place in three ways, according to the weather. During the cold season the heating apparatus on the floor is used without interruption; and by turning the handles on the balcony, the right or left side of the carriage, or both sides can be heated, as may be required.

The second-class carriages are ornamented inside with paintings, set in frames of teakwood. The seats are made of teak and covered with brown plush. These carriages have two divisions, each of them containing three compartments and a-half, and seating twenty-eight persons, together therefore accommodating fifty-six persons, leaving out the standing places on the balcony; they have windows on both sides. The carriages have sliding doors and a corridor of 2ft. 3½in. wide. These doors run on ledges at top and bottom, and are furnished with felt draught excluders. The third-class carriages have two divisions, of four or five compartments, with seating accommodation for ninety persons, besides standing room on the balconies. The middle part of the roofs of both kinds of carriages is raised and provided with ventilators. These carriages are fitted with Fox's patent bogie frames, of Siemens mild steel, of ·394in. thick, from the Leeds Forge Company, being for the greater part the same as the normal English bogie frames. The carriages have a total wheel base of 34ft. 6in., that of the bogie frames being 8ft.

At the trial of these carriages, in which the Board of Inspectors of the railway services took part, in connection with several engineers of the Dutch State Railway and the Board of Directors of the Dutch Central Railway Company, it appeared that they ran quite smoothly at a speed of 56 miles an hour.

For the sake of a trial, the second-class carriages had been provided with elliptical bolster springs between the swinging arrangements, the third-class with spiral springs, and during the trial the elliptical bolster springs proved the more satisfactory.

AT the meeting of the Physical Society held last week, Professor W. E. Dalby exhibited a friction dynamometer. The torque to be measured produces a twist in a spiral spring, and the object is to determine the amount of this twist. Side by side upon the shaft are two pulleys, one keyed to the shaft, and the other fastened to the end of the spring. The lead of one pulley upon the other, therefore, measures the twist. Two other pulleys are mounted upon a slide, and are joined up to the first ones by means of a continuous band similar to a Weston's differential pulley block. When the shaft is at rest the two pulleys on the slide are touching, but any motion of the shaft produces a twist in the spring, and therefore a lead of one of the shaft pulleys on the other. This produces a separation of the slide pulleys which is proportional to the lead, and therefore to the torque, and so, from a knowledge of the constants of the dynamometer and its number of revolutions per second, the power transmitted is at once determined.

RAILWAY MATTERS.

THE total length of line now worked by the South Indian Railway is 1024 miles.

THE total length of new lines for the construction of which powers have been granted in the West Highlands amounts to 122 miles.

THE preliminary Convention in connection with the Bagdad Railway was signed at Constantinople on Sunday by the Minister of Public Works on behalf of the Turkish Government.

THE Great Eastern Railway Company is now turning out at Stratford one engine a week, one carriage a day, and one wagon every hour. Ten thousand men are employed at the works.

IT is expected that next year will see the opening for traffic of the Mallaig extension of the West Highland Railway, which runs from Banavie through Arisaig to Mallaig, on the Sound of Sleat, a distance of just under forty miles.

A TELEGRAM from New York says the Baldwin locomotive works, at Philadelphia, have received an order from the French State Railways for the construction of ten passenger locomotives, to be completed early in the summer.

THE London and North-Western Railway directors have decided to allow the wives and families of the reservists called out from Crewe works to the seat of war half wages, with a minimum of 10s. per week. Nearly 200 men have gone out from these works.

DURING the month of October there were 292 train accidents in the United States, including 165 collisions, 121 derailments, and six other accidents, in which 44 persons were killed, and 168 injured. Eleven accidents were due to defects of road, 53 to defects of equipment, 102 to negligence in operating, eight to unforeseen obstructions, and 118 to unexplained causes.

SURVEYS for a broad-gauge chord line, projected to connect Godhra with Baroda on the south side of the Mhye River, which the Bombay, Baroda, and Central India Railway Company desires should form part of its own line, are now undergoing revision, and the earthwork is likely to be shortly proceeded with as a measure of famine relief. This chord line will run partly through Gackwaree and partly through British territory, will be about forty miles in length, and will shorten the present through rail distance between points on the main line south of Baroda, and points north and east of Godhra by about twenty-five miles.

THREE railway accidents occurred on Saturday night in Austria-Hungary. The most serious was that at Bia Torbagy, in Hungary, where, owing to the omission of a danger signal, a train from Buda-Pesth ran into one from Graz. Three carriages of the latter train were smashed, two persons were killed, several seriously and many slightly injured. At Karlsdorf, near Graz, two trains collided in a thick fog; but, fortunately, no one was killed. The third accident, took place at Marburg, in Styria, where an express train ran into a shunting engine. Only one person was severely hurt, though several received slight injuries.

THE Dearne Valley Railway Company, which was incorporated in 1897, has deposited a Bill for next session for the purpose of obtaining an extension of time for two years, from August next, within which to purchase the lands required for the authorised railways, and an extension of time for three years, from the same period, within which to complete and open the railways. The Bill, however, proposes to abandon the construction of three short sections of the authorised railways, and in substitution it is proposed to construct a short line to the property of the Houghton Main Colliery Company. Powers are also sought to construct other short lines.

THE Rhymney Valley Railway Company *v.* Brecon and Merthyr Tydvil Junction Railway came before Mr. Justice North in the Chancery Division of the High Court of Justice last week. His lordship ruled that agreement of 1864, by which the parties agreed that neither party would directly or indirectly seek any new line from one side of the valley to the other, had been broken by the defendants in the support they gave the Barry Railway in obtaining a Bill to connect the plaintiffs' line with the Barry line to the Barry Dock. The defendants' counter-claim, he held, absolutely failed, and must be dismissed, and the defendants must pay the plaintiffs' costs of both action and counter-claim.

AN agreement is reported to have been concluded between M. Rouffart, a Belgian engineer, and the Chinese Government for the construction of a railway connecting the Luhan line, from the neighbourhood of Kaifongfu with Honanfu, with the right of future extension to Si-ngan-fu, the provincial capital of Shensi. The Belgium syndicate operating the Luhan railway has obtained permission to extend the line from Lukoukiao to the west gate of Pekin. Sir Claude MacDonald has protested against the concession for the construction of the Kaifongfu-Honanfu Railway being granted to M. Rouffart, on the ground that the concession for the line was applied for some months ago by the Pekin syndicate.

THE report of the Bombay, Baroda, and Central India Railway for the half-year ended June 30th last, states that the total length of railway forming the system worked by the company during the half-year was 2633⅞ miles. The Tapti Valley Railway is now open for traffic from Vyara to Dhondaicha, a further length of 83½ miles, and is expected to be opened through to Amalner, where it will meet the Great Indian Peninsular Extension very shortly. The Rajpipla State Railway is also now open through to Nandod, 37½ miles in all. An extension—21 miles in length—of H.H. the Gaekwar's Petlad Railway to Cambay, on the Gulf of that name, to be carried out at the cost of the Baroda and Cambay States, has been sanctioned, and is being proceeded with. On its completion the extension will be worked by this company.

THE Board of the New York Elevated Railway has decided on equipping the line electrically. The construction will be of the largest magnitude in the world. The Westinghouse Electric and Manufacturing Company, of Pittsburgh, has been awarded the contract for the electrical apparatus required for the stationary installation, including eight three-phase alternating-current generators each of 6650-horse power capacity. These generators will be the largest ever designed or constructed, the nearest size being those built by the same company for the plant at Niagara Falls. The weight of each machine and engine complete will be nearly a thousand tons. The generators will be something over 40ft. in height. Twenty rotary converters, in units of 2000-horse power, each designed to produce direct current at 500 volts, will be installed in various sub-stations.

A SYSTEM of electric train lighting in use on the Paris, Lyons, and Mediterranean Railway has a dynamo provided on each carriage, arranged with its axis parallel to the rails. A friction wheel on a prolongation of this axis is pressed against one side of a running wheel. In this way the motion of the wheel is transmitted to the dynamo. Between the dynamo and the axle which drives it a friction clutch is provided, consisting of carbon brake blocks pressing on a bronze disc. The pressure of these carbons on the disc is such that slipping only commences when a current of 23 ampères at about 16 volts is being generated by the dynamo. This corresponds to a speed of about 30 miles per hour. At any higher speed slipping occurs, the idea being that the speed of the dynamo shall not increase, as an increased speed would also correspond to an increased torque. The dynamo is used to charge a battery of accumulators, which supply light to the train when it is stationary or only going at a slow speed.

NOTES AND MEMORANDA.

THE Berlin Academy of Sciences will celebrate the second centenary of its foundation on March 19th and 20th, 1900.

THE output of coal in Great Britain this year is expected to reach 225 million tons, of which about 50 million tons is for consumption by our Royal and mercantile navies and for export.

THE American Navy Department, says the *Standard*, after exhaustive experiments, has decided not to employ the Marconi system of wireless telegraphy in the American navy. The Department officials believe they can themselves perfect a system equally good, if not better.

"PETRO-ACCUMOBILE" is the name given to a motor carriage introduced by the Pieper Company, the motive power for which is, under normal circumstances, an oil engine, but under abnormal conditions an electric motor lends its aid. The motor derives its energy from accumulators.

A REMARKABLE instance of fluctuating values is to be found in the comparison of costs of steamers. It was stated recently that in 1894 a steamer cost £6 per ton deadweight, plates being about £5 5s. per ton, whereas to-day the cost is about £9 5s. per ton, £8 per ton being for plates.

THE Home Secretary has issued a notice under section 8 (1) of the Factory and Workshop Act, 1891, certifying that, in his opinion the processes of sorting, willeying, washing, combing, and carding wool, goat-hair and camel-hair, and processes incidental thereto, are dangerous or injurious to health.

THIS year there have been launched for the British Navy nineteen warships, aggregating 122,322 tons, and 196,400 indicated horse-power. This represents a national expenditure of nine millions. Last year there were launched thirty war vessels, the tonnage of which was 140,988, and the horse-power 253,600, the cost being about 8½ millions.

AT a recent meeting of the Paris Academy of Sciences M. Berthelot reported that the total amount subscribed for the erection of a statue to Lavoisier was 98,000f. M. Barrias has been commissioned to construct the statue and the bas-reliefs for the pedestal. The Municipal Council of Paris has granted a site for the statue in an open space behind the Madeleine Church.

THE length of pipes for filtered water in Calcutta now amounts to 315·05 miles. The average daily consumption of filtered water is 20,684,393 gallons, and the estimated daily consumption per head is 34·01 gallons in the town proper, and 19·86 in the added area. The gross cost per 1000 gallons is 2·66 annas. The daily supply of unfiltered water is 4,778,899 gallons, the consumption per head on a population of 436,393 being 10·95 gallons.

THE expedition of Baron Toll, organised for the exploration of the New Siberia Islands and Sannikoff Land, will set out in June next from a Norwegian port, whence it will proceed to the mouth of the Lena, on the banks of which, at a point above the town of Yakutsk, it will pass the winter. During the summer of 1901 the expedition will begin its explorations towards the north, picking up *en route* a detachment which will be sent forward from the main body during March, with a sufficient supply of dogs.

THE first electric launch to be used on the canals of Venice has recently made its appearance, no doubt much to the disgust of the gondoliers. A syndicate composed of local gentlemen has taken the matter up and secured this first launch as a type of what they wish to run for passenger traffic on the canals subject to the approval of the local authority. The launch, which is called the Alessandro Volta, provides accommodation for about 50 passengers. Its length is about 56ft., and width 10ft. It is equipped with 100 accumulators, and its mean speed will vary from seven to nine miles per hour.

THE *Novoe Vremya* gives a very unsatisfactory account of the state of the Russian military road thrown open to traffic last September between Enseli and Teheran. The only good section of the road in question is that running between Teheran and Kasbin, which was constructed twenty years ago by a Persian, Saade Saltane, and which is now still under the management of its maker. Along this section of the road a regular system of postal intercourse is maintained, while the section between Enseli and Kasbin is actually far from being completed. Seven bridges have yet to be built, and various parts of this section are so narrow and dangerous that travellers prefer still to make use of the old caravan road.

COAL is widely distributed throughout India, except in Bombay and Sind, the North-west provinces, and Oudh, Rajputana, and Mysore, where the mineral is either scantily distributed or entirely absent. The seams in Bengal and Assam are frequently from 50ft. and 80ft. to as much as 180ft. in thickness. The pits are often of considerable depth; at present the deepest appears to be about 700ft. In many cases the working of the seams leads to the escape of little or no fire-damp, so that the miners are able to work with naked lights. In 1895, 235 collieries were at work, but in 1896 only 172 were in active operation. At the present time Bengal produces more than three-fourths of the coal mined in India.

THE Royal Agricultural Society of England has issued the prize sheet for the meeting to be held at York from the 18th to the 22nd of June next. The total value of the prizes offered—exclusive of champion prizes and medals given by the leading breed societies—is £6820, of which £1676 are contributed by the York Local Committee. In the implement department the Society will offer prizes of £40 and £20 for general purpose horse-power cultivators, prizes of the same amounts for self-moving steam diggers, a prize of £50 for milking machines, and prizes of £20 and £10 in two classes for sheep-shearing machines, to be worked by power and by hand respectively. The entries for these classes close on March 15th.

INDIAN coal varies much in composition and quality. Most of it is quite suitable for ordinary purposes, while some of the samples—*e.g.*, certain of those from Bengal and Central India—are of excellent quality, equal to that of some of the best British coals. Though the coal in Bengal varies greatly in quality, much of it is excellent, the fixed carbon ranging between 50 and 60 per cent., and the calorific value exceeding 6000 cals.—equal about ten British thermal units—while the ash often does not much exceed, and in some instances falls below 10 per cent., and the sulphur is frequently present in but very small proportion. A great deal of the Bengal coal is serviceable steam coal. Many samples cake well and contain little sulphur, and the coke is, therefore, suitable for iron smelting.

THE power house of the Niagara Falls Hydraulic Power Company has recently received a new machine designed to give 5000 ampères at 175 volts. This machine, which is for electrolytic work, has two commutators. The two sets of brushes are connected in parallel with each other. The load on the machine is divided between the two commutators, or rather between the two armature windings, by an ingenious arrangement of varying the lead of one or other set of brushes. This is done by means of ratchet gear in one side of the field frame. These ratchet wheels work a brush-rocking apparatus by means of spur gearing. The cross shaft, on which the ratchets are placed, can either be worked as a whole, in which case the brushes on the commutators move together, or it can be split into two, so that one set may be worked separately to divide the load evenly between the commutators.

MISCELLANEA.

THE new Royal Yacht is to be undocked at Pembroke on January 3rd.

THE Christmas letters passing through Manchester were 500,000 in excess of the number recorded last year.

MR. ANDREW CARNEGIE has offered Dunfermline £20,000 for baths and a gymnasium as a Christmas gift.

AT a special meeting of the river Tyne Improvement Commission held on December 21st the estimates for the year 1900 were submitted. They include £53,750 for dredging and river works.

THE estimate for the Northumberland and Albert Edward Docks and railways amounted to £83,670; and the items, with one or two exceptions, already authorised by the Board, were referred back to the committee.

THE Glasgow Corporation, at a private meeting on Wednesday afternoon, accepted the offer of the National Conduit Company of New York for the electric tramways. The contract price was £151,000, or £10,000 lower than the British offers.

ACETYLENE gas for railway-carriage lighting has been in use for some time in the United States on the Cornwall and Lebanon Railroad. The gas is compressed, and is carried in the tanks formerly used on the same cars for ordinary illuminating gas.

CYCLISTS will be pleased to hear that the Middlesex County Council have passed a bye-law by which any person placing, depositing, or leaving any piece of broken article, or glass, or any sharp substance, not being road material, on any highway or place to which the public have access, shall on summary conviction forfeit and pay a sum not exceeding 40s. and costs.

WE hear from an authority in Germany that plans are being prepared at Essen for a great extension of Krupp's works. New buildings to cover practically four and a-half acres are to be erected, and it is computed that these, together with the machinery with which they are to be fitted, will require an expenditure of not less than about £175,000 sterling.

A REUTER telegram from Bremen states that the Norddeutscher Lloyd Steamship Company has purchased the fleet of the Scottish Oriental Steamship Corporation, consisting of fourteen steamers with a total registered tonnage of 20,942 tons, and will continue the service now carried on by the latter company between Bangkok, Singapore, Hongkong, and Swatau.

THREE Sheffield firms engaged in armour plate manufacture are said to have now practically completed the alterations and extensions of plant necessitated by new processes of manufacture and the demands of the British Admiralty, so that in the new year they will be able to produce armour at their full capacity. Work is being very expeditiously turned out at the present time.

A SCHEME for extending Euston Station so as to make it front upon the square has been submitted by the London and North-Western Railway Company to the St. Pancras Vestry. The plans involve the closing of Seymour-row, Melton-mews, Euston-place, Euston-grove, and Euston-crescent, besides portions of half a dozen other thoroughfares. Provision is made for the construc- of a new street and a new tunnel.

AT the monthly meeting of the Council of the county borough of Huddersfield it was moved and seconded that the Electricity Committee recommend the establishment of a municipal telephone service, subject to the subscribers of the Corporation system having the same facilities as the subscribers of the National Telephone Company's system. After some discussion the resolution was passed unanimously.

THE residence known as Hall-i'-th'-Wood, the birthplace of Samuel Crompton, inventor of the mule spinning frame, a combination of the spinning jenny by Hargreaves and the water frame by Arkwright, has been purchased by Mr. W. H. Lever and presented to the Mayor of Bolton. The original spinning mule made by Crompton is now in Mere Hall Museum, Bolton, and the Corporation have also recently become possessors of several other relics of the great inventor.

AN Admiralty order has been received at Pembroke Dockyard directing that the armoured cruiser Drake must be hurried on so as to be launched, if possible, in October next. The Drake was laid down on April 24th last. In the ordinary course her launch would not have taken place until the summer of 1901. She is 500ft. long, and will have a displacement of 14,100 tons. The engines will be of 23,000-horse power, and the maximum speed, with natural draught, 23 knots. These cruisers when complete will be the most powerful of their class in the world.

THE question of the water supply for Teesside is being considered by the Darlington Corporation Waterworks Committee. Information has been received that the Tees Valley Water Board is contemplating the furnishing of a supply to some of the works at Hartlepool by extending their pipes in that direction, and this the Darlington Committee looks upon as a violation of existing arrangements, and they have instructed the Town Clerk to formally apply to the Water Board for information. It is considered that water should not be sent out of the recognised district, especially as Darlington's needs are largely increasing, and all that is required by that town has to be drawn from the Tees.

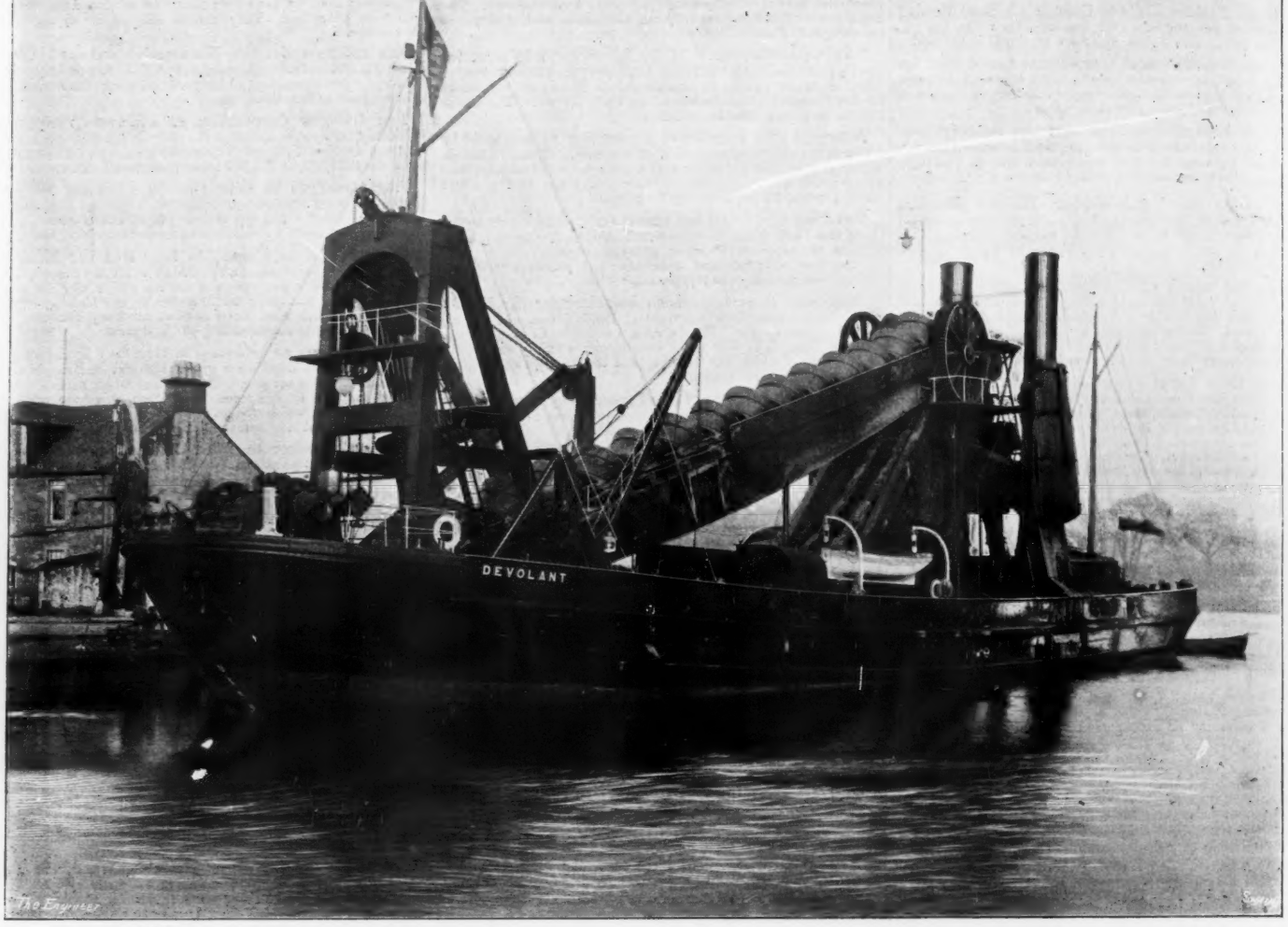
IN New Orleans electric motors are being largely employed for driving pumping plant. The district is flat and below the level of the Mississippi, so that in times of heavy rains pumps have to be resorted to to drain the town, and also for providing the canal with an artificial head, as into the Lake Pontchartrain it has not a sufficient fall. The artificial head is provided by a number of pumping stations placed along the route of this canal, and by means of these the water can be raised to a higher reach. Seven of these pumping stations will ultimately be required, but of these only three have been fixed up to the present. Electric current is provided from a central station on the three-phase system at 3300 volts.

THE imports of coal, now so largely carried to Hull by the various railway companies, will, it is expected, this year exceed any of its predecessors. The total entry of coal for the year 1898 reached 3,458,418 tons, against 2,655,744 tons in 1897, 2,420,416 tons in 1896, and 2,190,016 tons in 1895. Up to the close of November in the present year the imports had reached 3,248,160 tons, compared with 3,142,836 tons in 1898, an increase of no less than 105,324 tons. During the month of December, 1898, 316,656 tons were sent, and as only 210,328 tons are required to be sent during the present month to reach last year's tonnage, it is but fair to assume that the total imported will be reached, if not exceeded.

A COMPLETE electric search-light apparatus is about to be added to the New York Fire Brigade. It will be mounted on wheels, and will accompany the brigade to fires. Its purpose will be to light up dark parts of the street, and aid firemen in laying hose, setting ladders, or other work. The machine will resemble a fire engine in general appearance, and will use a similar boiler; but in place of the pumping machinery the engine will drive a dynamo, which will supply the lighting currents for the search-lights. There will be two search-lights, each with an 18in. projecting lens, and these will be carried on a platform behind the driver's seat. They can be used either from the platform, or removed and carried to any convenient place near by, their connection with the dynamo being kept by means of flexible cables.

STEAM DREDGER DEVOLANT

WILLIAM SIMONS AND CO., LIMITED, RENFREW, ENGINEERS



THE DREDGER DEVOLANT.

The engraving above is from a photograph taken of the dredger Devolant, while lying alongside the crane near the builders' works. This vessel was recently launched by William Simons and Co., Limited, London Works, Renfrew, and is shortly to be despatched to her destination. She has been constructed to the order of the Imperial Russian Ministry of Ways and Communications, and is intended for work at one of the ports on the Black Sea. The Devolant is a bow-well bucket ladder barge-loading dredger, which in its general arrangement does not differ very much from previous dredgers of this class already built for Russia by Simons and Co., but a noteworthy feature in connection with it is that it has the largest bucket-lifting capacity of any dredger afloat.

The vessel itself is 186ft. in length, 36ft. beam, and 13ft. depth, and dredging can be done to a depth of 36ft. below water level. The buckets are exceptionally large, having each a capacity of 36 cubic feet, whereas 25 and even 20 cubic feet is considered of large capacity when ordinary soil it being dealt with. The specified lifting or dredging power of the vessel was 1890 tons per hour. At the dredging trials, with an expenditure of 250 indicated horse-power, 2000 tons of spoil was lifted in one hour, which contrasts very favourably with the amount of power required by suction dredgers to raise the same quantity of sand.

The propelling machinery consists of a set of compound surface-condensing engines of 850 indicated horse-power, supplied with steam from two cylindrical boilers of large capacity, working at 120 lb. pressure. Each boiler is capable of supplying steam to either propelling or dredging machinery, this allowing of the dredger always having a boiler in reserve. A speed of 8¾ knots was obtained at the trials, being two knots in excess of the contract requirements. For regulating the cut of the dredger powerful winches, worked by independent engines, are fitted at bow and stern. The bucket ladder, which, with its chain of buckets, weighs, excluding dredgings, over 100 tons, is also controlled by a powerful set of independent engines. A machine-room and repairing shop is fitted on board, with lathes, drilling, and planing machines, &c. The vessel is fitted with electric light throughout, and on deck large lamps are placed to enable dredging operations to be carried on at night. Steam steering gear, a three-ton crane, and all the latest appliances are installed on board.

In addition to the Devolant, the principal work of the year accomplished by Simons and Co. includes the dredgers Pervi and Vtoroi, two exactly similar vessels, which have been built to the order of the Chinese Eastern Railway Company. These vessels are intended for extensive dredging operations in connection with the improvement of Port Arthur and Talienwan. They arrived at Shanghai on the 18th and 30th September respectively, after the very quick passage for dredgers of sixty-six steaming days. They are capable of dredging and discharging 1000 tons of soil per hour, and of working to a depth of 40ft. below water level, and in addition to being provided with a central chain of steel buckets, as in ordinary cases, and side shoots for loading barges moored alongside; they are fitted with sand suction pumps, and also centrifugal pumps for discharging overboard. To the latter is attached over 2000ft. of steel shore discharging pipes and floating pontoons having flexible connections for supporting the pipes conveying the dredged material on shore for land reclamation. The dredgers are each fitted with two sets of compound surface-condensing engines and two mild steel boilers working at 120 lb. pressure, an auxiliary boiler being provided for supplying steam to the mooring winches when required.

The same firm, it may be added, has at present under construction, to the order of the Suez Canal Company, for the dredging of the Port Said roads, the largest bucket hopper dredger in the world. She is of the stern-well type, having a hopper capacity of over 2100 tons of dredgings. The vessel is 274ft. long, 47ft. breadth moulded, and 19ft. deep. She will dredge to a depth of 39ft. 4in., and will have a lifting capacity of 1800 tons per hour, the buckets each having a capacity of fully 30 cubic feet. For propelling the vessel there will be two pairs of triple-expansion engines, either set of engines being capable of driving the dredging gear, steam being supplied from two steel multitubular boilers of 160 lb. working pressure. The hopper of this immense dredger will be one large apartment placed amidships, and the hopper doors will be worked entirely from one position by one man.

THE UNITED STATES HARBOUR-DEFENCE VESSELS.

One of the provisions of the session of Congress last year was an allowance for the construction of four harbour-defence vessels for the United States navy. The vessels are to be of the Monitor type, and to be built after the plans furnished by the Navy Department. On October 1st bids were opened, and awards have already been made, the costs ranging from 825,000 dols. to 875,000 dols. Three of the ships will be built on the Atlantic Coast, and one on the Pacific, and a maximum of twenty-seven months is set by the bidders for the completion of the work.

The Monitor is not a discarded type, by a vast deal, in the United States, and while the type has not proved itself to be in every respect all its very warmest advocates claimed, still it has undeniable advantages within its legitimate province, and in moderate weather and an easy sea is more than a match for any thing of like displacement, but of another type. For sea-going qualities the Monitor has given ample evidences of satisfaction, and has lived through many a gale unhampered that would have more than taxed a craft of greater freeboard; but that is not the only requisite in a fighting ship, and the very generous margin of stability that made the type seaworthy also made it too "quick" for a good gun platform. In the present design docking keels have been fitted, and, to a certain extent, they will act much as bilge keels would, and just so far add to the steadiness of the vessels.

The primary purpose of the ships is for harbour-defence duty, but their sea-keeping features have been carefully considered that they may be the better fitted for rapid cruising from one port to another than the vessels of the Monitor class now in active service. In points of equipment and mechanical facilities the vessels are very decided advances upon anything of their order now in the United States navy, and, within the reasonable scope of their powers and application, should prove very formidable fighting machines.

A description of one ship applies equally to the others, and for example the Arkansas will be described. The ship will have a water-line length of 225ft., the stem being carried well forward below the water and formed into an effective ram; she will have a maximum beam of 50ft., and, upon a normal displacement of 2700 tons, will draw only 12½ft. of water. Her possible usefulness about the West Indies or in the shallow waters of the Gulf is apparent at once.

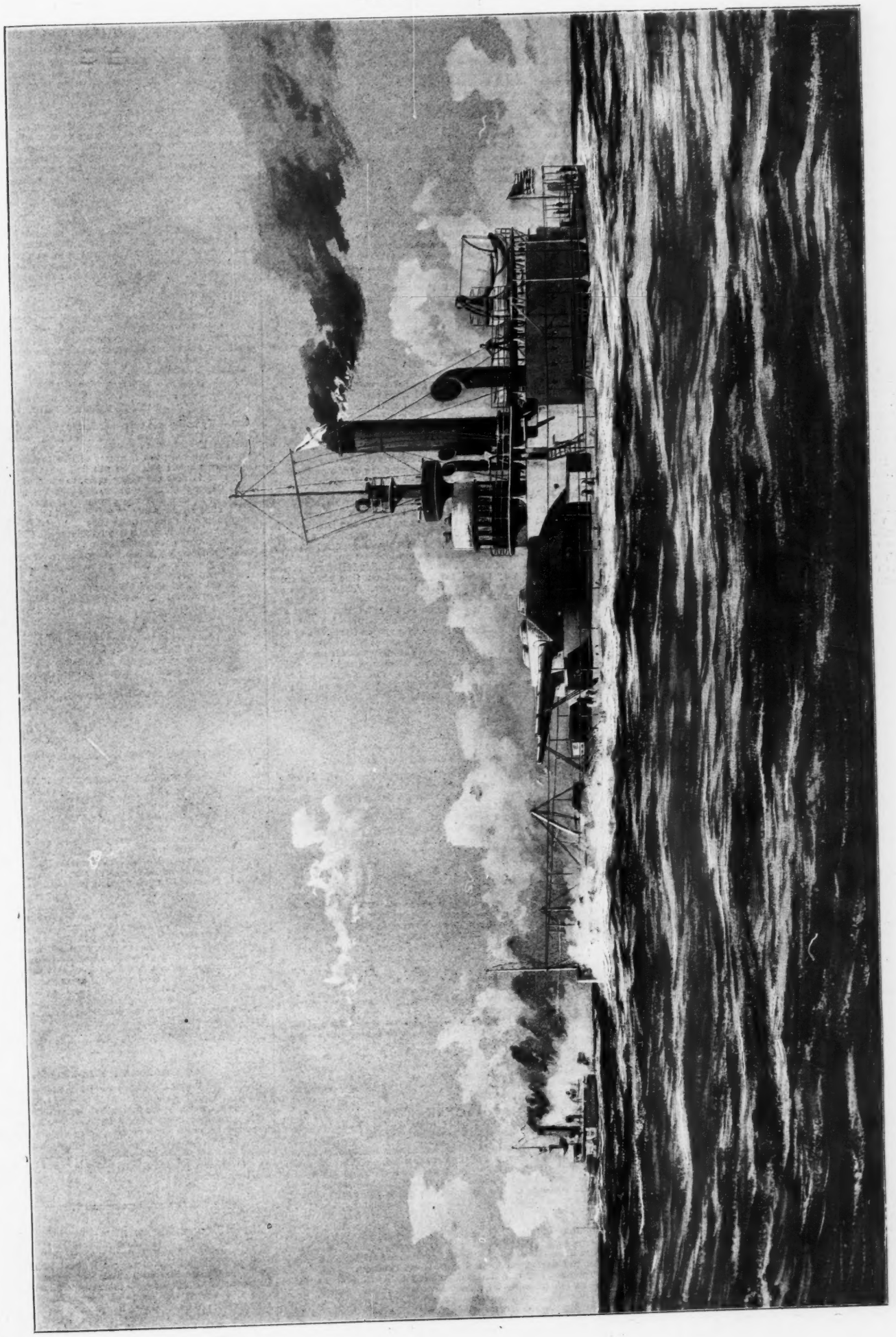
The hull is of steel, unsheathed, with an inner bottom reaching up to the armour shelf, and ranging fore and aft throughout nearly the whole length of the ship. There is the usual sub-divisioning of the intramural space, as well as of the whole interior of the craft. In the double bottom, just below the boilers, feed-water will be carried, leaving just so much more room for other purposes in the boiler space. This is a departure from the service practice heretofore, and is being adopted for some of the other new ships.

The hull will be guarded by a continuous band of armour extending from the main-deck line down to a maximum depth of 30in. below the water-line amidships, but reaching only down to the water at the stern. This armour will have a maximum thickness of 11in. at the deck line throughout the region occupied by the engines, the boilers, and the magazines, tapering thence to the armour shelf well below water. Forward and abaft the vital space, the armour will be graduated by easy steps till it terminates at the bow and the stern in thicknesses of 5in. It is said to be the present intention of the Department to have this armour treated by the Krupp hardening process—really the Harvey process carried farther into the plate; and if this be so the defensive properties of the steel will be considerably increased—perhaps as much as 20 per cent. The protective deck, or, more properly, the main deck, will be composed of two thicknesses of ¾in. plating, of which the upper course will be of nickel steel. This will be sufficient defence against the acute angle at which most plunging shots will have to strike. This main deck will be planked, but, being exposed to the weather, will not be fireproofed.

A five-sided superstructure will occupy the central portion of the main deck. In the lower half will be quartered some of the officers, and there too will be the galley, the armoury, some wash-rooms, and spare space for the housing of part of the crew if so desired. On the next deck above, *i.e.*, the superstructure deck, will be placed the major part of the rapid-fire portion of the battery. The hammock berthing will also be in the superstructure on that deck, lending a very mild protection to the gun crews of some of the smaller pieces. On the bridge or uppermost deck will be carried the chart-house,

UNITED STATES MONITOR ARKANSAS

(For description see page 646)



the boats, and all of the 6-pounder rifles. This and the deck just below, like the main deck, being exposed to the weather, will not be fireproofed; but the berth deck being under cover will be covered with linoleum placed right upon the fundamental plating. Wherever possible, woodwork has been omitted and supplanted by light metal bulwarks, &c., but where found needful for the sake of health and the saving of weight the wood used will be carefully fireproofed.

All hatch coamings are raised well above the main-deck line, and those in the open forward are carried high enough to permit of their being left open even when the deck forward is well awash with broken seas. By this means the crew space forward on the berth deck can be well lighted and comfortably ventilated when cruising in fair weather—a desideratum of prime importance when doing duty in warm southern waters. In heavy weather these hatches would be battened down, and the fresh-air supply would then be drawn down through the mast and the big ventilators, while a good deal of the foul air of the boiler spaces, especially, would be carried up between the double casings of the smoke-stack. The Monitor is not naturally a cool craft when under steam, but everything has been done in these ships that could be done to make them much more comfortable than any of their predecessors, and there is no doubt but that they will prove so. Electric fans and electrically-propelled blowers will furnish most of the induced ventilation.

The ship will be driven by twin screws, actuated by two triple-expansion engines, which will be placed in one water-tight compartment. These engines will be of the vertical inverted-cylinder direct-acting type, each with a high-pressure cylinder of 17in., an intermediate-pressure cylinder of 26½in., and a low-pressure cylinder of 40in., the stroke of all pistons being 2ft. The collective indicated horse-power of the propelling and the circulating pump engines will be 2400 when the main engines are making in the neighbourhood of 200 revolutions a minute. Steam will be supplied at a working pressure of 250 lb., by four water-tube boilers, having a total grate surface of quite 200 square feet and a total heating surface of 8800 square feet, and capable of supplying all the steam on shipboard when running at full power.

The amplest possible means have been provided for a supply of cool air for the engine and the boiler-rooms when under steam. The armoured ventilator abaft the smoke-stack will be the main duct, while the two smaller ones just forward will answer the double purpose of air shafts and ash hoists. All of these ventilating passages will be guarded by armour gratings to keep out explosive shell, and the big, main ventilator will be surrounded by several inches of armour up to a height of 4ft. above the main-deck line.

The vessel will be lighted by electricity, while the turret mechanisms and all the ammunition hoists will be actuated by the same energy. By the adoption of electricity so general, the presence in long passages of heated steam pipes is obviated, and in this way alone a very considerable reduction of temperature will be effected under service conditions. The main battery will consist of two 12in. breech-loading rifles; the secondary battery will be composed of four 4in. rifles; while the auxiliary battery will include three 6-pounders and four automatic 1-pounders. The 12in. guns will be mounted in a single barbette turret of the balanced type, having an inclined face with a pitch of 42 deg. The armour for the turret and the barbette will be 11in. thick, and will be treated by the Krupp process. The total sweep or arc of fire of these two guns will be 300 deg., leaving a dead angle, dead aft, of only 60 deg., which could be easily covered by a slight swing of the ship to either side. The four 4in. guns will be mounted on the four principal corners of the superstructure deck, where they will command an enviable field of fire. These guns will be protected by shields. The 6-pounders will be mounted on the bridge deck, while the 1-pounders will be placed on the hammock berthing amidships, and up in the single top of the military mast. The 12in. and the 4in. guns are to be designed for smokeless powder, and it is promised that they shall be a considerable advance upon the pieces of like calibre, of native design, now in service. For a ship of her size, the Arkansas will be a very effective fighting machine, and more than an equal, within her field of action, for any craft of like displacement. There will be a conning tower 7½in. thick, just below the chart-house and abaft the turret, and all means of communication will be led thence through an armoured tube 3in. thick down below the main deck.

The ship will carry two search-lights—one forward on the mast and the other on a stand at the after-end of the bridge deck. There will also be the usual outfit of electric signals and side and running lights. Modern facilities in every direction will add to the comfort and convenience of the officers and crew and to the working efficiency of the craft, and nothing will be spared that can bring the vessels typically up to date in every sense. The bunker capacity untrimmed will be 200 tons of coal, and that amount will be carried upon the normal displacement. More, of course, can be carried in an emergency, but the normal allowance at the ordinary cruising rate of speed will be amply sufficient to give the ship a considerable radius of action.

These vessels have really been called into being through the pressing needs of the growing ranks of the naval militia for proper training schools aside from vessels temporarily detailed for such service. In many instances only the ancient Monitors of the war of the Rebellion were assigned for that work, and with their old boilers and engines and muzzle-loading smooth-bore guns, they were not such drill grounds as the modern seaman and the volunteer officer need. With the single exception of torpedo instruction, these four harbour-defence vessels cover practically all that is needful in a general preliminary education in naval warfare of to-day, and in that capacity alone the ships will pay well for their construction.

The electric generating plant is to consist of four units, each unit to have an engine, dynamo, and combination bed-plate, and each dynamo a rated output of 400 ampères at 80 volts. This plant will supply motive energy for the ventilating blowers, and for all ammunition hoists and the mechanisms controlling the turret and the loading of the two 12in. rifles, and power for all the lights in the ship. The complement of the ship will consist of something like 130 persons, with berthing space for a larger crew if necessary.

ORDERS are reported to have just been given at Toulon for the erection of new French Government foundries for the casting of naval guns. The foundries are to be built in the most accessible part of the arsenal, in order that the heavy guns, when completed, may be easily taken aboard the ships to be fitted by means of hydraulic travelling cranes. The plans of the buildings have already been approved by the authorities in Paris.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ECONOMIC HAULAGE.

SIR,—Most of your correspondents on the above subject lay great stress on the fact that larger wagons are required if we are to compete successfully with the Americans in low freights, and they all suggest the American bogie wagons as the best to adopt. I think I can show that our present pattern of English wagons is capable of carrying much more than at present, by increasing their height to the maximum that the loading gauge will allow. It is a great pity the diameter of our wheels is so large, it raises the trucks such a height above ground that much valuable space is lost which could otherwise be utilised for carrying. However, if our coal trucks were built with sides as high as vans, they would carry double as much as they do at present, and yet take no more room. The wheels would have to be slightly stronger than now, and also the springs, and the sides kept in by very strong stays, and the falling doors replaced by side doors similar to those of vans. Such a truck as I have described would not weigh more than seven tons, and being able to carry 18 to 20 tons of coal, the proportion of deadweight carried would be as low as 40 per cent. Of course with higher-sided trucks the screens at collieries would have to be raised or the sidings lowered to allow the wagons to pass under, and possibly some means would have to be devised to check the fall of the coal from so great a height into the trucks, to prevent breakage of coal and injury to the wagons. For filling up off the ground the wagons would be comparatively useless except through the doors, but for ordinary goods they would be as good as vans, as they would keep bales and such like goods from falling off, and could be sheeted either by ordinary tarpaulins or by blinds fitted on the top side of the wagon out of the way of harm from coal, &c. Such trucks should not be much dearer to build than ordinary 10-ton coal wagons, their only difference being in their height being extended to the limit of the loading gauge.

Our colliery proprietors and wagon builders, both railway and private, are not as progressive as they might be. They are content to build the same kind of wagon year after year, and do not assist one another by suggestions or improvements, and in many cases they resent alterations of any sort. Inducements should be held out to traders to employ larger wagons by offering lower rates for truck loads of 15 tons or over, private enterprise would soon devise suitable wagons and put them in traffic. At present there is no such encouragement, and consequently it matters little to the trader whether his traffic is carried in one wagon or two. Something will have to be done soon on some of the busier parts of our railway system. The recent block of traffic around Sheffield is a sign of what we may expect in other districts if we do not take care. It will be far cheaper to employ larger rolling stock filled up to the loading gauge than the present box wagons we are content to employ, and by thus saving in the length of the trains we may be able to do without the stupendous widenings of railways which are at present the only alternative. At the same time I would recommend wagon builders to try building wagons with longer wheel bases. The Midland Railway is now building some very useful timber trucks on four wheels which are nearly twice as long as the old pattern. These wagons are very useful for other traffic besides timber, such as agricultural machinery, hay, straw, empty cases, &c., and other light and bulky goods. I would also suggest the building of a few trial six-wheel trucks with radial axles for general traffic, and also of bogie trucks. We are now in the experimental stage as far as this country is concerned, and consequently our improvements must be gradual and not too hasty, lest some should suffer inconvenience and loss; but that our present rolling stock will have to be greatly altered and improved in the near future goes without saying, if we are to keep our rates anywhere near to those of our competitors in Europe and America, and thus retain our supremacy in trade which we have held so long.

December 26th. TRADER.

PASSENGER REFRIGERATION TRAINS.

SIR,—*Apropos* of the correspondence regarding the disadvantage to which our railways suffer compared to American, I think, from a passenger's point of view, none is more marked than the heating of our trains.

I am a frequent traveller by the East Coast route between England and Scotland, and find the heating of the carriages little short of scandalous. For example, leaving King's Cross by the 11.30 p.m. on December 9th, the temperature in the sleeping car was 38 deg. at starting, and never exceeded 40 deg. on the journey. Again, I was a passenger by the 2.20 dining car train on the 22nd; the temperature between London and York was 50 deg., mainly owing to the exhalations of the numerous occupants in the car, as no apparent heat emanated from the apparatus. After York a number of the passengers left, and the temperature fell to 45 deg., at which point it remained until our arrival in Edinburgh.

At one station I went forward to the engine, and suggested to the driver that he might pass a little steam through the train. He very civilly replied that he would do what he could, but that it generally took him all his time to keep his engine in steam without passing any back. At another station—there being two engines on—the driver of the train engine told me he kept up a pressure of 60 lb. in the train pipe, but that owing to leakage it never seemed to have any effect.

The worst case in my experience, however, was the arrival in Edinburgh, on the 23rd, of the 11.30 ex King's Cross with a luggage van, having no through pipe in front, and cutting off the heat from the whole train. The morning was a bitterly cold one, and the train fifty minutes late, so that the passengers' lot cannot have been an enviable one. Needless to say the antiquated warming-pan was not procurable. A PASSENGER.

Kinaldy, December 26th.

AMERICAN MACHINE TOOLS.

SIR,—Seeing the article from an American Engineer in your present week's issue of THE ENGINEER, I thought it would not be out of place if I gave you my experience of American machines up to date. I must candidly say that it has been anything but good; not only in the tools not being true, but weak and faulty in design and lubrication. A 14in. screw-cutting and surfacing lathe I have, has such a poor tool holder on it, that we find that we can only give it small work, until such time as we can fit it with an English one. Also a 72in. radial drill, the rack on the spindle was so narrow that it was impossible to use the proper feed; this broke down three times, and we had an allowance from the makers each time to repair it. Also the spindle is not balanced.

The next tool is a horizontal boring mill with a 5in. spindle. When set to work we found, with countershaft running at 75 revolutions, that on account of the cutting speed when in the lowest gear, the largest cylinder we could bore would be 12in. Imagine a 5in. bar for this. We were told to run the counter shaft 25 revolutions. This we refused to do. Fancy driving a counter shaft 25 revolutions from a motor running 840 revolutions.

Before the machine had run twenty-four hours one of the sleeves for the feed motor seized. This would be about 12in. long, and no means of oiling the centre. We also find when facing the ends of cylinders that the work is not good, as the outer support for the bar is not rigid. This machine was not true in the bar, neither was the 72in. radial spindle drill true with the base.

We have other American machines coming in, but I must say that if we could have procured English tools in time, we should have preferred them, as we find that they need less upkeep, and can be relied on. As regards small tools, such as twist drill grinders, general tool grinders, and small saws, they are very good. None of our tools of foreign make are above two years old.

December 16th. WM. STEAD.

AN EXPERIMENT IN SURFACE TENSION.

SIR,—In the course of an interesting investigation on capillarity and surface tension I made the following experiment. I took a straight piece of glass tubing about ¼in. internal diameter, and fixed it vertically in a glass of water, the top of it projecting about ¼in. Over its edge I hung a tiny syphon, the shorter leg entering the tube about ⅛in.; the other leg was very little longer, and did not touch the surface of the water. The level of the water in the vertical tube was raised by capillary attraction some ⅛in. so that the inner limb of the syphon projected a short distance into it. By using a very small india-rubber syringe I found it possible to so squirt water into the top of the vertical tube that a small bubble was carried down to the bottom of the tube, where it remained. Before placing the syphon in position I filled it with water, also by the aid of the syringe. The surface tension of the water at the two openings was sufficient to hold it in. The position then was this:—A vertical tube projecting above the level of the water; one leg of a syphon entering the higher level of the water in the tube, the other above the outer level of water; a bubble stationary near the bottom of the tube. I then began to fill the vessel very cautiously. As soon as the level was so far raised as to touch the water in the outer leg of the syphon the imprisoned bubble began to rise, driving the whole contents of the tube out through the syphon. The experiment is exceedingly pretty, and if a very tall glass vessel—I used one some 16in. long—is employed, and the vertical tube is taken to the bottom and filled with some brightly-coloured liquid, the effect is very striking.

My object in writing this account to you is partly to bring what may be a useful experiment before the notice of professors and physicists, but mainly to call attention to the great accuracy with which the level of a liquid can be measured by this simple device.

London, December 26th. L. ST. LAWRENCE.

RAISING WATER BY AIR.

SIR,—My notice was only called this morning to the remarks in your valued paper of the 15th inst. *re* above. I would recommend "Mining Engineer" to procure a copy of my paper from Mr. Angus Macpherson, the secretary of the Institution of Cleveland Engineers, where I think he will find what he wants. But he must take it that the rising main, to work economically, be inserted 60 per cent. under water, and that the air pressure must be slightly in excess of the pressure of water due to this 60 per cent. That is, for a lift of 40ft. from the surface of the water the pipe must be under water 60ft.

He asks, "Why does not a bubble expand downwards?" I would ask, Why does a bubble rise to the surface?

With regard to the loss between air receiver and the pump, practically speaking, this is not worth taking notice of, at the same time there is a small percentage; then there is a certain loss by the reduction of temperature, friction of air in air pipe, &c., but as a rule the loss is nothing compared with that of ordinary pumps.

With regard to the actual consumption of coal, this was given me by those who have installed the system in America, and must be taken for what it is worth; the best plan is to try it.

The pump is undoubtedly most economical, simple in the extreme, without moving parts or valves in the well, and is an interesting and beautiful accomplishment, and has a great future before it.

I have a working model in glass about 10ft. high at my works, which I shall be glad to show anyone who likes to take the trouble to come here.

Tees Railway and Engineering Works, CHARLES WOOD.
Middlesbrough-on-Tees, December 21st.

SINGLE CRANK COMPOUND ENGINES.

SIR,—Referring to recent correspondence respecting tandem compound engines with both valves on one spindle, may we point out that the arrangement referred to by Mr. Harker in your issue of November 17th, and by the Vauxhall Ironworks Company in issue of November 10th, is not the same as and not anticipated by the Kingdon engine referred to and built by Messrs. Simpson, Strickland, and Co. The latter, when brought out, was a great improvement on the ordinary class of launch machinery then in use, but it has the defect of having one large combined slide valve to serve both cylinders and with the boiler pressure on the back of it. This, of course, involves a very heavy valve drive, and renders the plan disadvantageous for any but the smallest size of machinery. The special advantage in the two other designs consists in the combination of an easily worked piston valve for the high-pressure cylinder suitable for high pressure, and a slide valve for the low-pressure, only exposed to receiver steam as usual, and the whole arranged without a stuffing-box between high-pressure and low-pressure chests. However, this arrangement is not new, for we designed it about seven or eight years ago, and have been using it ever since. We enclose photograph of a set of 5in. and 9in. by 8in. engines so arranged for a working pressure of 180 lb., and of which we supplied six sets to one company.

Gloucester, December 23rd. W. SISSON AND CO.

LOCOMOTIVE LIFE-GUARDS.

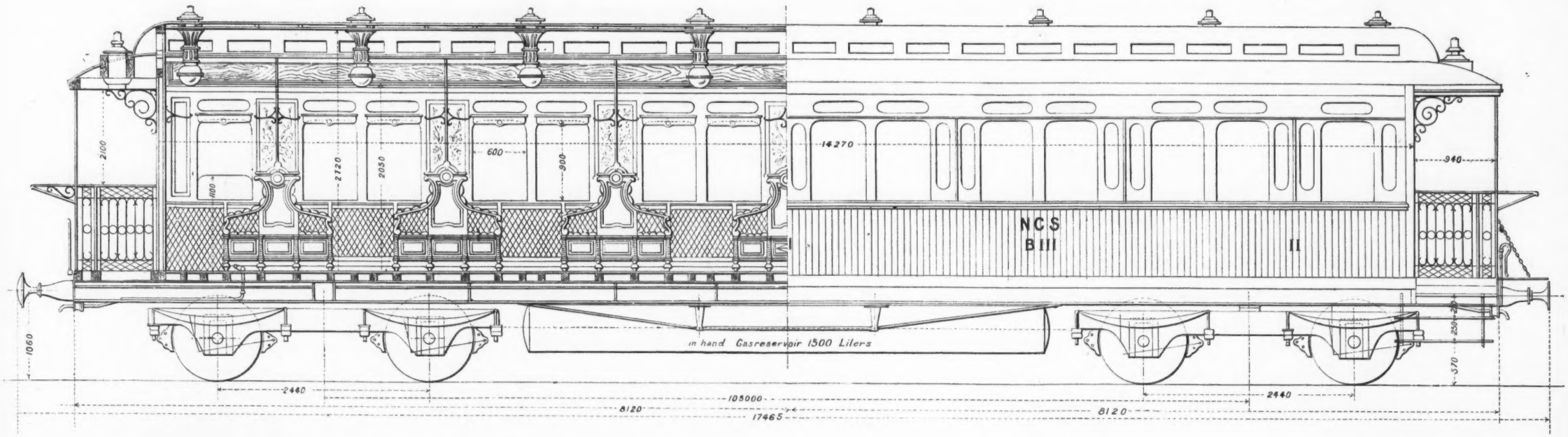
SIR,—May I ask some of your "locomotive" correspondents why the life-guards are made of the present pattern? Presumably they are a survival of the fittest, but their utility is very questionable, and if they strike a fairly heavy object at high speed they generally break off like a carrot. Why should not the guard be directed forward at an angle that would bring its end about under the front of the buffer? It would then not only be stronger, but would tend to lift any large obstacle out of the way.

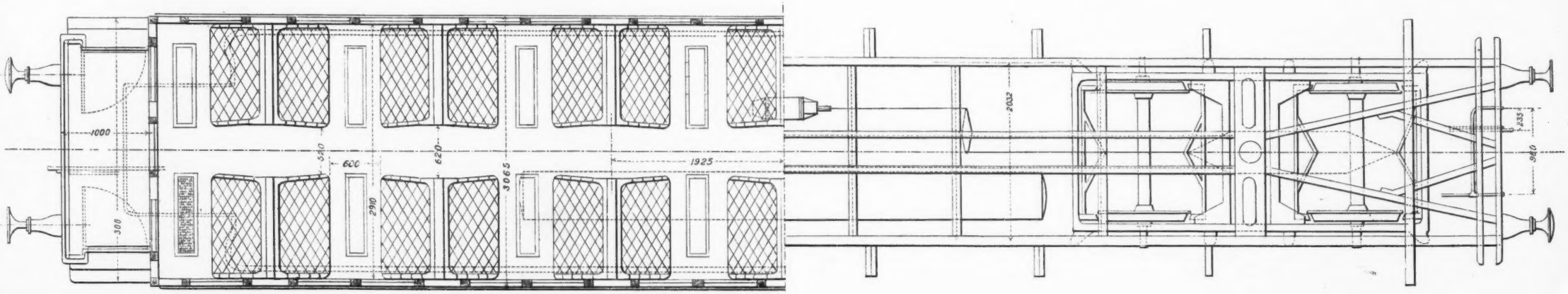
December 27th. NOT A LOCO. MAN.

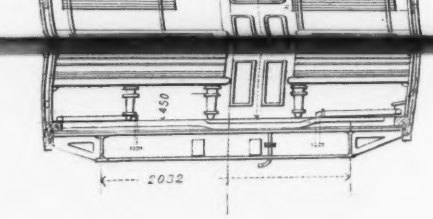
NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet Engineers: J. J. Walker, to the Royal Arthur, additional for the Katoomba; Thomas Whebby, to the Hotspur; William F. Pamphlett, to the Vivid, additional for the Implacable; Thomas Green, to the Colossus; W. J. Harding, to the President, additional, as Engineer Overseer at the works of Messrs. Maudslay and Messrs. Thornycroft; William Chas. Fincham, to the Osborne; Henry S. Rashbrook, Edwin Cornish, William Milton, and Joseph T. Parkis. Chief Engineers: W. W. Lawrence, to the Victory for the Chamois; Henry Humphreys, to the Speedy. Engineers: Alfred E. C. Deacon, to the Assaye; Robert S. Jennings, to the Magdala, additional for the Plassy; E. D. Mallinson, to the President, to assist Engineer Overseer in inspection of naval gun mountings at works of Vickers, Sons, and Maxim, Barrow-in-Furness; H. Coopper, to the President, additional, as Engineer Overseer for Steamboats, &c., in the London district, including the Isle of Wight; Albert E. Collings, to the Duke of Wellington, additional for the Recruit, in lieu of a Chief Engineer. Artificer Engineer: Edward H. Williams, to the Speedy.

NEW CARRIAGES OF THE DUTCH CENTRAL RAILWAY COMPANY

MR. J. W. VERLOOP, LOCOMOTIVE SUPERINTENDENT, ENGINEER



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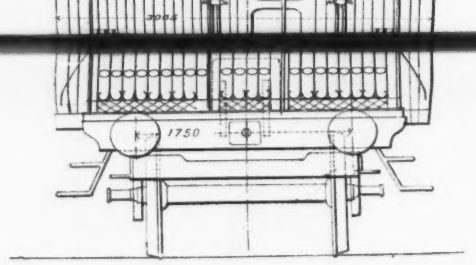
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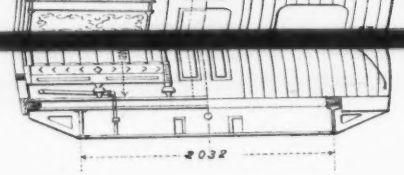
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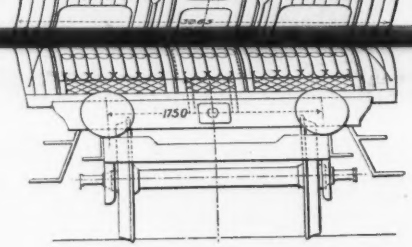
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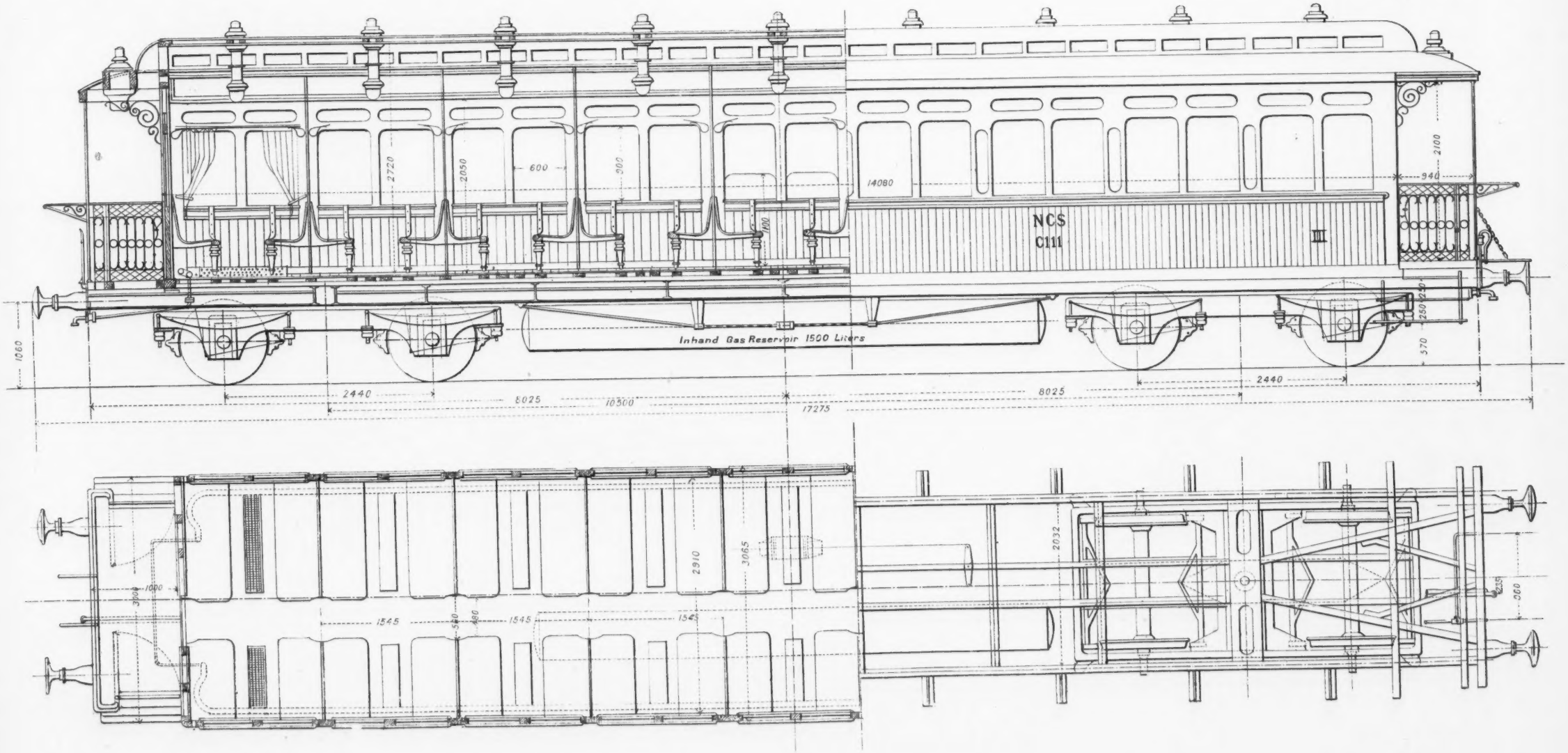
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Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

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TWO-PAGE SUPPLEMENT—NEW CARRIAGES OF THE DUTCH CENTRAL RAILWAY COMPANY.

TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. G. (Wolverhampton).—The Board of Trade have nothing to do with the matter. Apply to the chief engineer of any of the boiler insurance companies, stating your qualifications.

F. N. (Wellington).—"Mining Engineer," to whom your letter has been forwarded, requests us to state that he does not live in Shrewsbury; that he wrote during the period of a short visit; but that, if he did, he would have much pleasure in complying with your request.

C. B. (Chichester).—(1) We are not aware of the existence of any line of soundings taken at distances of 100ft. across the Irish Channel. (2) Write to the Secretary of the Trinity House. (3) We fancy that good Admiralty charts supply all the latest and most trustworthy information available.

B. DE J.—The subjects in the technical examination for shipwright surveyor to the Board of Trade are iron and wood shipbuilding and the ordinary displacement, metacentric, stability, alteration of trim, and strength of girders calculations. The questions set are very similar to those in the Science and Art examinations for honours in naval architecture. Thearle's works on "Naval Architecture," published by Collins and Co., of Glasgow, are suitable for your study. The age limit is between twenty-five and forty-five years, but men of about thirty are preferred.

MEETINGS NEXT WEEK.

RÖNTGEN SOCIETY.—Thursday, January 4th, at 8 p.m., at 20, Hanover-square. Paper, "The Interpretation of Skiagrams," by Mr. Chisholm Williams, F.R.C.S.

GEOLOGISTS' ASSOCIATION, LONDON.—Friday, January 5th, at 8 p.m., at University College, Gower-street, W.C. Address on "Our Older Raised Beaches," by Sir Archibald Geikie, D.Sc., F.R.S., &c., Director-General of the Geological Surveys of the United Kingdom. Paper, "A New Rhætic Section at Bristol," by Mr. W. H. Wickes.

DEATHS.

On the 25th inst., at Cap Martin Hotel, Mentone, ALEXANDER HALL WILSON, shipbuilder, Aberdeen, aged fifty-three.

On the 15th inst., at Wynberg, South Africa, of wounds received in action at Magersfontein, HERBERT CECIL WILLOUGHBY BERTHON, of Cleeve Court, Somersetshire, Lieutenant 2nd Battalion Royal Highlanders (the Black Watch), in his thirty-fifth year.

THE ENGINEER.

DECEMBER 29, 1899.

SUPERIMPOSED TURRETS FOR WARSHIPS.

WITH the object of getting the greatest possible arc of fire for their big guns, the Americans fitted superimposed turrets on the battleships Kearsarge and Kentucky. Each complete turret carries two 13in. guns on one level, and two 8in. guns above them. The two smaller pieces have thus the same arc of fire as the 13in. weapons. The Americans are now exercising their minds over the main armament for their new battleships, and the Board of Construction having recommended the double turret again, a good deal of discussion is taking place on the subject. At the time the Kearsarge was being built we expressed an opinion that a mistake was being made in adopting the superimposed turret, but in view of the importance that all things concerning the construction of navies are to our country it may be as well to look briefly into the matter again. Let us first see what the advocates of the system advance in its favour. In the first place, we have, of course, the fact that the 8in. guns can train on either side. Thus two guns are able to do what it takes four guns to accomplish when they are placed in separate turrets. A large saving of weight is effected; in the first place, because two complete turrets are done away with; and, secondly, because the barbette armour and the training engines do double duty. It is said that the total saving of weight on the Kearsarge and Kentucky is 460 tons, as compared with the independent turret system of the Oregon. It is further claimed that the risk of the disablement of the 8in. turret is reduced because it is protected by the 13in. turret, and that the ship will be easier to fight because blast interference will not have to be taken into consideration. Let us look at these arguments in detail. The claim that two guns can do as much as four is true within certain limits. The Kearsarge and Kentucky can, it is true, train their one pair of guns on either broadside, but on the other hand they have only two guns at each end to fire axially with the ship, instead of the four of the Iowa, and the three vessels of the Oregon class. Moreover, the broadside is the same when fighting with one opponent, but is less by four powerful guns when both broadsides have to be used. Following this line of argument further, let us suppose that the Oregon meets the Kearsarge in action; after a certain time the four 8in. guns of the Kearsarge are put out of action, and four of those belonging to the Oregon. This vessel has then only to make a complete turn to present an entirely new battery of four powerful guns to the disabled Kearsarge. The issue of the battle could hardly be in doubt for a moment. But the agument is not concluded there. One well-placed shot from the heavy guns of the Oregon striking near the base of the turret of the Kearsarge, would almost to a certainty put the turret, though, perhaps, not the guns, out of action; that is to say, it would prevent training. In fact, it is by no means certain that a heavy projectile hitting the upper part of the turret would not have the same effect. And we venture to think that it is more likely to be hit than the lower part, both because it presents a more prominent target and because it is raised to a higher level, and would be struck by badly-aimed shots directed against the main turret. We believe we are right in thinking that more projectiles which miss the target pass over it than strike the sea in front.

Having seen how the arrangement affects the ship from the enemy's point of view, we may now see how it affects its own crew. In the first place, we have four guns practically tied together. They must all train in the same direction, but they can elevate and fire separately. What would be the effect of firing all the guns simultaneously we do not like to say; possibly means have been taken to prevent such an occurrence, or possibly it is felt that the doctrine of chances is sufficient protection. Merely firing the two upper guns together at the long leverage they have, must put a heavy load on the roller race. It is possible that even with this leverage the pressure is not as great or greater than that caused by the 13in. guns, but the smaller guns will fire at four or five times the rapidity of the larger weapons, and they will have, therefore, a cumulative effect which may prove in no small measure serious, if several successive lengthy actions have to be fought. There is, however, another serious point which the Americans have not been slow to perceive. When one gun of a pair placed on a revolving platform is fired it exerts a turning effort, because its line of recoil is not over the centre of rotation. Brakes are fitted to turrets to limit this turning action, but they are powerless to prevent all motion, and consequently the firing of one gun alters the sighting of its companion. This is sufficiently inconvenient when two pieces are employed, and it is more than doubly so when four guns are involved, two of which are firing at at least twice the rate of the others. As far as we are aware, no method of mitigating this evil has been suggested, and no "apology" for it has been written. In connection with the same point, it may be observed that the work of the captain of superimposed turrets will be by no means easy. The captain of of the upper guns will desire to fire, presumably, at more frequent intervals than the captain of the 13in. guns, and chances of simultaneous, or almost simultaneous, fire are therefore likely to occur; but the effect of one piece firing before the other is, as we have already shown, to disturb entirely the sighting of the second. Possibly some arrangement is provided by which one captain commands all four guns. Again, a system of drill which will allow of a fair degree of independence in training of the guns must be somewhat complicated. Suppose, for the sake of argument, that the 13in. guns fire once every three minutes, and the 8in. guns once every minute, the smaller guns—when the big guns can load at any position of training—can aim and fire twice without interfering with the big guns, but to do that they must fire at regular intervals. Thus the system is not sufficiently flexible in the matter of time in firing, nor as to aiming, for it would seem that the only practicable method of avoiding confusion is for all four guns to attack the same vessel at the same point. In a general action the advantage of this would be open to question.

On the whole, then, whilst we are bound to admit that the saving in weight and the reduction of machinery is advantageous, we do not see that sufficient is gained to balance the many disadvantages of having all the eggs in one basket and all the weapons in one hand.

AMERICAN IRON TRADE CONDITIONS.

PERHAPS the most interesting of recent developments in connection with the iron trade of the United States is to be found in the decision of the miners of lake Bessemer ores to raise prices for next season. For the past season the figure was 2.53 dols. per ton at lower lake ports for the Norrie grade; for the coming season it will be 5.50 dols., and we can well believe the *Iron Age* when it tells us the advance is "rather larger than was expected." Although a considerable rise was inevitable in the circumstances, the trade activity and the demand for iron and steel seem scarcely to warrant one of more than 100 per cent. The new price will be equal to 9·7 cents per unit compared with rather less than 4·5 cents for the last season, and when this increase is kept in mind, together with an appreciation of about a dollar per ton in coke and substantial rises also in labour and freights on raw materials from receiving ports and coke ovens, some fair notion will be obtained of the high rates which must rule for finished products. The New York paper already referred to estimates that the cost of making Bessemer pig iron in the Schuylkill valleys next year will be about 14.0 or 15.0 dols. per ton for those who are forced to purchase their ore in the open market. It is true that only a comparatively small proportion of the Bessemer pig made in the Central West is produced by firms so situated, most of the large companies, as we have previously explained in these columns, controlling part at least of their supplies of ore and fuel, so that the cost to them will show a reduction varying with the conditions affecting each particular concern. But even they will not be in a position to secure their raw material really cheap, and should the demand be sufficiently large and well sustained to call for even a moderate quantity of metal produced by the "outside" furnaces, the net saving must be inconsiderable. Non-Bessemer ores next year will sell at lower lake ports at 4.25 per ton, which is equal to about 8 cents per unit, and to makers of basic and foundry grades this means an advance almost equal to that on Bessemer pig.

The questions that are inevitably suggested by these seemingly extravagant prices are:—Are the orders on hand and in prospect large enough and profitable enough to justify them? And cannot foreign ore of similar grade be imported at a smaller cost? We will take the second question first, incidentally remarking that the high prices have so stimulated active mining on the deposits to the east of the Alleghenies that there is every probability of Lake Champlain ores being sent into the Cleveland and Pittsburgh districts in very considerable quantities. It is of much significance to learn on the best trade authority that a Philadelphia firm during one

week recently sold for spring delivery between 175,000 and 200,000 tons of Newfoundland ore to nine different concerns in the Eastern Pennsylvania districts at 7½ cents per unit free on board cars at Philadelphia. Quality for quality, there is a considerable saving to be made by purchasing Newfoundland ores. Then, again, there has been talk of importing in large quantities from Spain. The price of Spanish ore in English markets has advanced very appreciably since the revival of engineering activity in this country, and should America come in as a large purchaser, it is clear we shall see a further rise. Already we are told that that country has been asking for 400,000 tons, and that "mineowners may, if they choose, book orders for two years in advance." The import duty is quite inconsiderable, and having regard to the discrepancy between the prices of domestic and foreign ores, it cannot operate as a serious obstacle. A condition of things necessitating the importation of foreign ores into the United States was one scarcely conceived by the framers of the last tariff; but it has come about, and Europe is involved because a further rise in Spanish ore, coupled with the high prices of coal and coke, must be a serious thing for manufacturers here whose requirements have not been covered. For this reason alone the unprecedented briskness of trade in America is of very immediate concern for us. This brings us to a consideration of the first named of the questions arising out of the situation. On November 1st the weekly output of pig iron for the country was 288,522 tons, compared with 278,650 tons on October 1st and 243,516 tons at the beginning of the year. The production on January 1st, when Bessemer pig fetched 10.75 dols. at Pittsburgh, was at the rate of 12,662,800 tons per annum; on November 1st, when the price stood at 24.75 dols., or, say, £4 15s., it was at the rate of 15,003,144 tons per annum, and it is of interest to observe in passing, as indicating the slowness with which extraordinary demands are met, that the advance of 130 per cent. in the price between the two dates only induced an increase of 18½ per cent. in the production. This does not give much hope of early relief to consumers of finished goods from an embarrassment which it is hardly an exaggeration to characterise as a steel famine. The manufacturing activity appears, from reports to hand, to have quieted down considerably in the last few weeks, but this is usual towards the end of the year; and as to the outlook, the *Iron Age* assures us that "in the great majority of the different branches the product is engaged for many months to come, running in some directions far into the second half of the next year. Many producers are still so far behind in their deliveries that a quieter spell is welcomed as a relief. In some branches it will require intense activity during the whole of the usually dull period to work off the long-delayed orders and the contracts at hand for future delivery." Making due allowances, it yet seems certain that business next year in the manufacturing districts of the States will continue brisk, and that prices will not show any material slacking off, during the first six months at all events. As the thing reflects on trade here, it is well to recognise this probability. Evidence of the growth in exports of iron and steel goods is found in the Treasury statistics. The October figures of shipments of iron and steel and manufactures thereof are 9,593,453 dols. against 7,299,185 dols. in October of last year. The total for the ten months ending with October is 86,162,258 dols. against 67,290,560 dols. in the corresponding months of last year. Both in price and quantity the figures of the export trade show an increase, and in practically every article and class of articles. Bar iron, for instance, shows an increase of nearly 100 per cent. in quantity exported in 1899 as compared with 1898; bars or rods of steel, an increase of 30 per cent.; wire rods of steel show an increase of 25 per cent.; steel sheets and plates an increase of over 100 per cent; and wire nails an increase, in round terms, of 200 per cent. in quantity.

It is worth while making a brief reference, in connection with the spread of manufactures in America, to the progress of the Southern States. The new steel works of the Tennessee Coal, Iron, and Railroad Company at Ensley, Alabama, were opened on November 30th, and the event has been called "the beginning of an economic revolution in Alabama and an important stage in the development of the resources of the South." The undertaking is notable for mere extent and volume of product. The company owns half a million acres of mining lands, and works twenty blast furnaces and thirty collieries. Its furnaces have a capacity of 70,000 tons of pig iron a month, and this capacity will shortly be increased to 100,000 tons per month. Its engagements already made, so we are told, call for more than half a million tons of pig iron—that is to say, for the entire product of the furnaces for the period of seven months. A considerable part of these orders comes from abroad. It is said that the average price obtained for its iron is 17.50 dols. a ton, but that is a detail. The magnitude of the company's operations may be judged from the fact that the output of the entire country is only a little over ten million tons of pig iron annually. The Birmingham mines and furnaces contribute about one-tenth of the whole. It is expected that the new steel works, however, will take not less than 1000 tons a day. The men of the Northern States see much significance in the establishment of iron and steel manufacture on such a scale as this in Alabama, and they are among the first to allow that a prosperity and promise of growth, such as the South never dreamed of in the days when cotton was king, await it now under the new *régime* of iron manufacture. The inauguration of successful manufacturing industries leads inevitably to increased wealth and population. If the South has in the past failed to keep abreast of the North in these primal elements of growth, it is because the North turned its attention earlier to the multiplication of its industries, and in particular to those which gave employment not only to the hands of its wage earners, but to the brains of its men of capacity and to the genius of its inventors. But the great mineral wealth of the region about Birmingham could never have been developed, and the big new steel works which are to convert the pig iron of the Tennessee Coal, Iron and Railroad Company into steel billets and steel rails would never have been erected if capital had not found in these enterprises the promise of profitable employment. If the stage of capitalism—that is, the stage of having free capital in large amounts ready to seek good investments as they offer themselves—has not yet been reached in the South, it is largely because, as the *New York Times* reminds us, the era of industrial development has only just set in there. That stage will come as the result of the new forces now at work. Meanwhile, Northern capital supplies the lack and justly reaps the reward. The chief creator of the steel works in Alabama, which have required the expenditure of 1,500,000 dols., is Mr. James T. Woodward, of New York City, whose faith in the future of the South is shown by what he is doing for the development of its newly-revealed resources. Mr. Woodward is, we take it, no philanthropist, but a plain, hard-headed man of business, and that is about the best augury for the success of the enterprise.

CHEMICAL ENGINEERS.

IN an inaugural address by Mr. J. B. Johnson, at the University of Wisconsin, the attention of American engineers was directed to the necessity of teaching chemistry in connection with mechanical engineering. In the opinion of the speaker, the success which Germany was making in industrial chemistry was attributable to this combination. In America—and equally in this country—at present, except in the one branch of metallurgy, a knowledge of chemistry is rarely associated with an engineering education, and consequently many facts of which advantage might be taken, were the professions of chemistry and mechanical engineering combined in one person, were not infrequently lost. "So long," said Mr. Johnson, "as one mind conceives only the chemical relations and processes, and another mind must devise the appliances to be employed, the result must of necessity be inadequate, uneconomical, and disappointing. The problem is always one and indivisible, and an attempt to make two problems of it must result in at least partial failure." This is a statement of opinion which all engineers will endorse, and it behoves us as much or more than it does America to turn our attention to this subject. We have colonies and foreign possessions which in all probability are full of undiscovered riches, and which will require the combined knowledge of chemistry and engineering to develop. What has been said of science itself may with almost equal truth be said of manufactures—we have so far only touched the fringe. There are vast resources in minerals and plants of which we have at present only the most superficial knowledge. Can we doubt that similar discoveries to those of the coal tar colours, and of cellulose, still wait the coming of the engineer who shall have at once the chemical knowledge to foresee their presence, and the mechanical experience to develop them on a commercial scale?

A RAILWAY RECORD.

WE take the liberty of cutting the following extract from a letter from a correspondent which the *Times* published yesterday morning:—"One has heard of some eccentricities of a railway company, but my experience of last Saturday evening on the Great Northern beats the record. I left King's Cross at 8.15 by a train whose engine and carriages were labelled 'Edgware.' My destination was East Finchley, and a porter informed me the train called there. But when we got to Finsbury Park, the engine-driver, or some other official, remembered that he did not live at Edgware, so the labels were taken off, and we went another way for a change! When I got to Hornsey I thought there must be a mistake, so inquired. 'No, sir; this is not the way to East Finchley. You must go back to Finsbury Park.' 'But,' said I, 'I got into an Edgware-road train at King's Cross, which should have been right for East Finchley.' 'Oh, yes, Sir; but we changed the train at Finsbury Park into a New Barnet train.' I returned to Finsbury Park, and reached East Finchley in two hours from the time I left King's Cross!" This does indeed seem to us to break the record! Could anything be more annoying, and at the same time more inexplicable? Last Saturday evening was very foggy. This was perhaps an excuse for diverting the train—the company has probably issued a notice of such a possibility during fog—but there was no excuse for sending a passenger to a wrong destination when he had been informed before leaving the terminus that the train called at the station where he wished to alight.

MANCHURIAN RAILWAYS.

THE remarks which Lord Charles Beresford made on the civilising and expanding influence to be expected of railways in China are borne out by the latest consular report from Manchuria. The trade of this district is increasing with great rapidity, having risen from less than £3,800,000 in 1896 to over £4,600,000 last year, and there is no doubt in the mind of Mr. Consul Hosie that, provided the present conditions of taxation are maintained and preferential railway rates are discountenanced, that good times are still in store for the people of Manchuria. This remote district labours under certain disadvantages of position of climate, but they are almost compensated for by its exemption from the very heavy internal taxation of foreign and domestic trade which interferes so greatly with the progress of Central and Southern China. At present not more than one-third of this rich country has been tilled, and the population being very sparse, labour is expensive. But the greatest need is improved means of transport, for as things are at present, in summer the roads are quagmires, and for four months in the winter the rivers are ice-bound. Consequently nearly all produce has to be carried in carts at heavy rates. It is perfectly evident that the cure for such ills is the construction of numerous railways to tap all parts of the district, and the good which the existing lines have already effected is sufficient earnest of the results to be expected from further developments.

WAR ARTISTS AND LONG GUNS.

THE desire to present a pictorial record of the war in South Africa has led to the production of many remarkable illustrations. Most of our readers will be familiar with the astounding coloured prints which are supposed to give ideas of general engagements, and most of them will know how to discount them. But apart from these not a few artists have tried their hands at depicting guns of various sizes, with the most misleading result. It is true that our naval guns are long, but none are so long as that shown in an illustrated periodical recently, which stretched from the foreground into the middle distance. These remarkable errors are due to the artists in this country working from photographs, which give very exaggerated perspective. If the artists would spend a little time in the perusal of the official handbook of ordnance, or would examine the correct drawings of guns which technical journals give from time to time, they would not fall into these outrageous errors. They are all acquainted presumably with the method of correcting distorted perspective, and could with a little care avoid presenting the remarkable weapons which figure in their pictures.

DOCKYARD NOTES.

THE Swedish ironclad Svea, which recently underwent certain modifications, is to be entirely reconstructed this winter. It is expected that the work will be completed in April or May next. In the winter 1900-1901 the Göta will be taken in hand; in the winter 1901-1902 the Thule. These two will not, however, be re-constructed on the same plan as the Svea. Further details have not yet appeared.

EVERY day almost brings forth something new with regard to the French navy. The latest is an expenditure of £20,000,000 on new ships and coast defence, so that an ambitious programme may be looked for soon.

A LOCAL Portsmouth newspaper estimates that 2000 tons of coal have quite recently been lost by spontaneous combustion at coaling point, Portsmouth. An immense reserve, in bulk equal to a good sized mountain, is now accumulated here, and it is practically always on fire. Now and then the fire is "got under," but it continually breaks out again. It is said that the coal is piled about four times as high as it should be, and, further, that it more or less lies in a pit. Consequently there is no drainage for rain water. Steps are being taken to drain the place, but whether these will be satisfactory when done is an open question.

ANOTHER trouble is that the coaling point at Portsmouth, constructed at great labour and expense, is an utter failure owing to the abnormal increase in size that ships have of late made. The Channel Squadron ships never lie at the coaling point to coal—the coal is put into lighters, and thence transferred to the ships. As the lighters are got ready beforehand, the loss of time over this is more apparent than real; still there is some loss, and there is a considerable loss in labour. The elaborate appliances at coaling point are used only by destroyers and gunboats. This being so, the point has become more and more a mere magazine, and what it lacks in length and breadth has been made up for in thickness—hence the creation of the burning mountain. What is really needed is the construction of an entirely new coaling point somewhere else, but this would entail a very heavy expenditure.

A HEAVY BANK ENGINE.

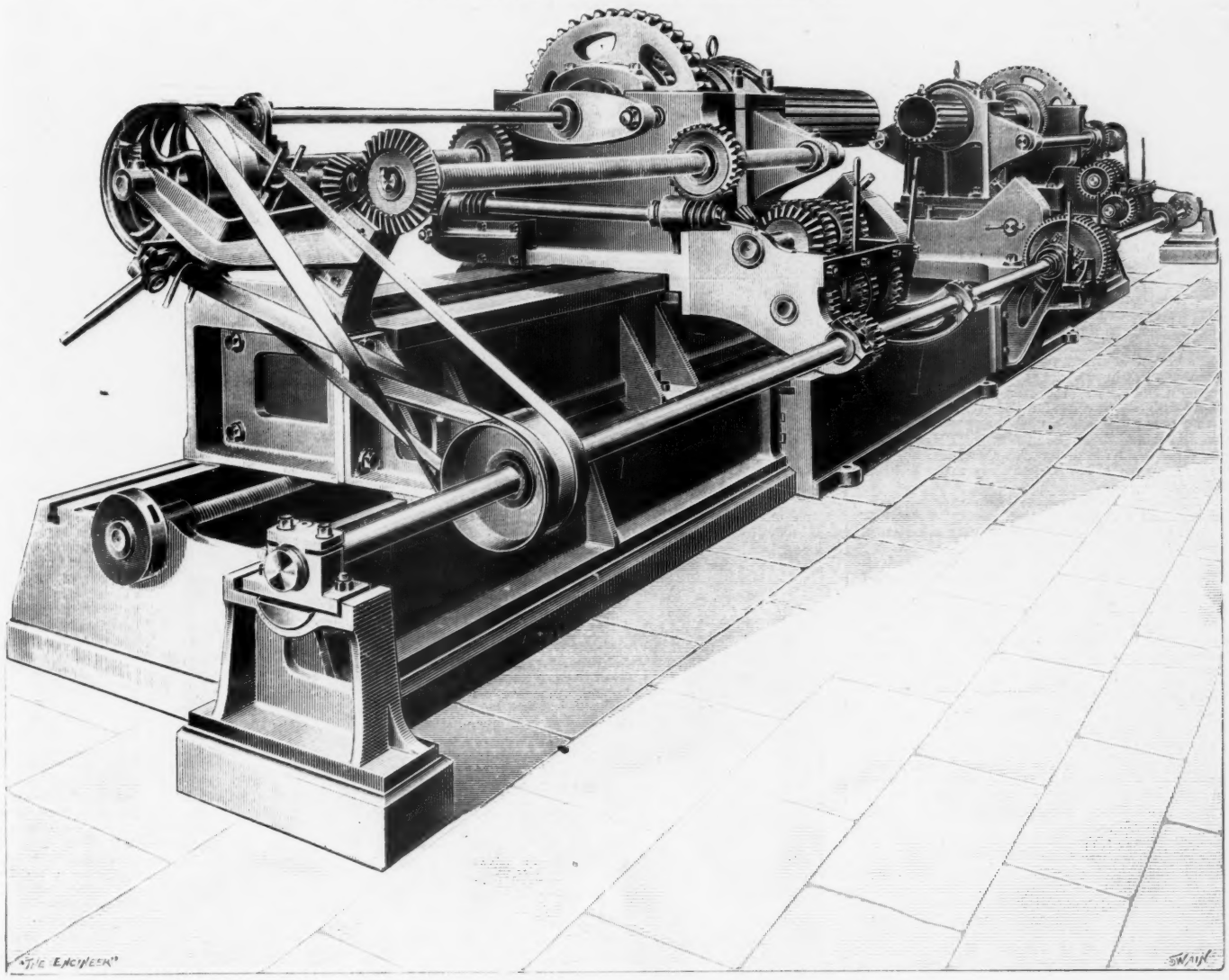
FOR helping the heavy coal trains over steep gradients the Delaware and Hudson Railroad has had six large eight-coupled bank engines constructed by the Schenectady Locomotive Works. They are of the Consolidation type, having eight driving wheels and a two-wheeled leading bogie. The long, wide fire-box for burning fine anthracite coal is behind the cab, and extends over the frames, which are of cast steel. The third driving axle is the main axle. For this particular service ample steaming capacity is necessary, and the valves are also set differently from those on ordinary engines, there being no inside lap, and no lead with the lever in full gear. The dimensions of these engines are as follows:—

Cylinders	22in. × 28in.
Steam ports	18in. × 1¼in.
Exhaust ports	18in. × 2¾in.
Valve travel	5¼in.
Valve lap: inside, none; outside	¾in.
Valve lead in full gear	none
Driving wheels	4ft. 2in.
Bogie wheels	2ft. 6in.
Driving wheel base	16ft.
Total wheel base	24ft. 2in.
Driving axle journals	9in. × 10in.
Main crank pin	7in. × 5½in.
Coupling crank pins	5½in. × 4½in. and 5in. × 8⅝in.
Boiler, diameter	6ft. 2in.
Fire-box, size	10ft. × 9ft.
„ depth	5ft. 1in. to 6ft. 1in.
„ crown stays, radial	1in.
Plates in barrel	⅜in. and 7/16in.
Plates in fire-box	⅜in. and 7/16in.
Tubes, 417, diameter	2in.
Tubes, length	14ft.
Heating surface, tubes and water-tubes	3123 square feet
Heating surface, fire-box	226 „
Heating surface, total	1349 „
Grate surface	90½ „
Boiler pressure	180 lb.
Tractive power	41,469 lb.
Exhaust nozzles, double	3⅝in., 4¼in. and 5⅝in.
Funnel, diameter at base	1ft. 4in.
Funnel, top above rail	14ft. 11in.
Weight on driving wheels	157,500 lb.
Weight, total	176,000 lb.
Tender:	
Wheels (two four-wheel bogies)	2ft. 9in.
Journals	5in. × 9in.
Wheel base	15ft. 8in.
Coal capacity	8 tons
Water capacity	5000 gallons
Wheel base of engine and tender	51ft. 1½in.

THE IRON AND STEEL INSTITUTE.—The President—Sir W. C. Roberts-Austen, K.C.B., D.C.L., F.R.S.—Council, and members of the Iron and Steel Institute, have presented to Mr. Thomas Ashbury, C.E., of Manchester, an oak cabinet containing a silver tea and coffee service, on which the following inscription is engraved:—"Presented to Mr. Thomas Ashbury by the President, Council, and members of the Iron and Steel Institute, as a mark of appreciation of his great services on the occasions of the meetings in Manchester in 1887 and 1899."

INGOT BORING MACHINE

CRAVEN BROTHERS, LIMITED, MANCHESTER, ENGINEERS



NEW BORING MACHINE.

THE above illustration shows a double-ended ingot boring machine. This is capable of boring ingots up to 12ft. long, and 5ft. 6in. over the corners, from both ends simultaneously, or from either end separately, as required. The maximum diameter of trepanning bar the machine will take in is to bore a hole 16in. diameter. The foundation bed is 44ft. long, with the upper surface planed with ⊥ bolt slots the full length, to receive the two top beds carrying the boring headstocks and guide pedestals for supporting the outer ends of the trepanning bars. Each boring headstock has a worm and worm-wheel motion, with three sets of changeable spur gearing to suit the diameter of the holes to be bored. The machine is driven by fast and loose pulley or by electric motor, as desired, with a clutch to stop or start each boring head, to work them either together or separately. The boring headstocks are traversed in the bed with self-acting feed by two steel screws geared together; also with quick withdrawing motion by open and cross belts, to withdraw the bars in or out of the hole rapidly. The wide central part of the foundation bed carries two strong V blocks, each with three strong setting-up screws for adjusting the ingot, and made with horns to fasten the lashing chains by which the ingots are held in position. The trepanning bars are made fitted with steel cutter heads, and steel tools are inserted for trepanning; also a boring head to take the place of the trepanning head with four knife tools to face up the end of the ingot before starting trepanning. The driving end of each bar is made with a face plate coupling to bolt to the coupling on each driving headstock. The bars are turned, bored, and fluted, to give the necessary clearance for the cuttings. The weight of the finished machine is forty-six tons. Machines of this type have been supplied by Craven Brothers, and are in successful operation.

NAVAL WORK IN ENGLISH SHIPYARDS AND ENGINE FACTORIES IN 1899.

IN view of the present great public interest manifested in all that has reference to the strength and preparedness of our first line of defence—the "British Navy"—it seems fitting that everyone interested in that Navy should be informed as to the additions just lately made to it; and as we have in our issue of December 8th posted our readers as to what has been done and is doing in some of the Scotch shipbuilding centres in this direction it seems opportune that we should in this our last issue for the closing year briefly record the actual work accomplished during its course, in warship construction generally, in the principal shipbuilding and engineering establishments in England.

So far as our Royal Dockyards are concerned, it will be no news to our readers to be told that little information is at any time given to the public or the press as to the actual progress of work in them, so that all we can say in reference to such constructions is necessarily brief. Giving, however, the work effected in the passing year in these establishments the primary place in our record, there has been completed out of hand during its course one first-class battleship and one first and one second-class cruisers at Portsmouth, one third-class cruiser at Devonport, one first-class battleship at Chatham, and one third-class cruiser at Sheerness: while there are in various stages being completed—two first-class battleships at Portsmouth, three similar ships and two second-class cruisers at Devonport, two first-class battleships, one third-class cruiser at Chatham, two third-class cruisers at Sheerness, and one first-class cruiser at Pembroke.

Of the vessels completing, two were laid down within the year, viz., the battleships Venerable and Bulwark—the former at Chatham on January 2nd and the latter at Devonport on March 20th; while there are now in hand—laid down this year—still building the armoured cruiser Drake at Pembroke and the battleship Montague at Devonport. Preparations are being made at Chatham for the construction of the battleship Albemarle, and at Pembroke the armoured cruiser Essex.

The foregoing brief summary of the warship constructions effected in our Royal Dockyards, however, by no means includes all the vessels built for the British Navy in English shipyards during the year, there having been a large output of such vessels from the private yards of the country.

Taking the East Coast yards in the order of their occurrence coming southwards, that of Sir W. G. Armstrong, Whitworth, and Co., at Elswick-on-Tyne, should come first in our rota, but the particulars have been overlooked and will be given later on. The next firm on the Tyne engaged in work for her Majesty's Navy is that of Hawthorn, Leslie, and Co.—their shipyard being at Hebburn and works at Newcastle—who have in hand a large amount of work, comprising machinery for vessels building in our Royal Dockyards, and vessels for the same service under construction in their own.

Of the machinery supplied by the firm during the year is that of 13,500 indicated horse-power for the battleship Ocean, built at Devonport, which has now passed through her trials, and is being taken over by the Dockyard authorities. For the battleship Bulwark, built and now completing at Devonport, the engines and the greater part of the boiler work have been delivered, and are now being fitted on board. The vessel was launched in October, which was six months earlier than the date originally specified for the delivery of the machinery; but the progress of fitting it is fully up to date as that of the ship, notwithstanding the rapidity of construction of her hull attained by the Dockyard. As the contract for the machinery of H.M.S. Kent, which will be of 22,100 indicated horse-power, was only accepted last October, the work in connection with it is only in the initial stages.

At the Hebburn Shipyard there is being completed the torpedo boat destroyer Viper, previously described by us, fitted with turbine engines by Parsons' Marine Steam Turbine Company. This vessel has already been once to sea and attained a record speed on this her maiden trip of upwards of 32 knots an hour. Her further trials are just about to take place. There is also in hand in the shipyard the destroyers Greyhound, Racehorse, and Roebuck; these vessels are all framed, and the first-mentioned one will be launched in about two months. They are of the 30-knot class, similar to those already built by the firm, having propelling engines of 6000 indicated horse-power and Yarrow boilers. The destroyer Havock, originally fitted with boilers of the locomotive type, is being refitted with Yarrow boilers of 4000-horse power, and new auxiliary machinery by Hawthorn, Leslie, and Co.

At Palmer and Co.'s Shipbuilding Works at Jarrow there have been completed during the year for the British Navy the third-class cruiser Pyramus of 2150 tons displacement and 7000 indicated horse-power, together with the 30-knot destroyers Spiteful and Peterel, each of 320 tons displacement and 6000 indicated horse-power; while the torpedo gunboats Skipjack and Speedwell, of 750 tons displacement and 6000-horse power, have been fitted with new engines and boilers. All these vessels have twin-screw triple-expansion engines, supplied with steam by Reed water-tube boilers.

In addition to the foregoing completed vessels, Palmer's Shipbuilding Company is building for the Government the hull and machinery of the first-class battleship Russel, which will be fitted with twin-screw four-cylinder triple-expansion engines of 18,000-horse power, supplied with steam by twenty-four Belleville boilers working at 300 lb. pressure. It has also in hand for the Government two destroyers similar to the Peterel.

Earle's Shipbuilding and Engineering Company, of Hull, has handed over to the naval authorities the two third-class cruisers Perseus and Prometheus, built and engined by it. These are steel-built twin-screw vessels of 2135 tons displacement and 7000 indicated horse-power. The engines of the first-class battleship London, which are of 15,000 indicated horse-power, are now being erected in the company's shops, and the boiler work is well in hand. The under-water fittings of this vessel—building at Portsmouth—are nearly all fixed in place, and the stern tubes and shafts are fitted. Very great difficulty has been experienced by Earle's Company in getting boiler tubes for these ships sufficiently perfect to pass the very severe inspection and tests of the Admiralty overseers, few makers now undertaking this class of work, consequent on the very rigid inspection insisted on.

From the Humber southward there is no warship building until we reach the Thames, where we find the existing builders of this class of vessels very fully employed. At the Chiswick shipyard of J. I. Thornycroft and Co., of the special type of vessel known as destroyer, her Majesty's 30-knot vessels Coquette, Cygnet, and Cynthia of this class have successfully passed through their trials and been delivered during the year. The Albatross, 32-knotter, will possibly be completed before its end. The Stag, a 30-knot vessel of the same class, for our Navy, is well advanced towards completion, she having been launched last month with all machinery on board. Two torpedo boats of a new type, for the British Navy, will be laid down by Thornycroft and Co. as soon as the necessary material for their construction can be obtained

from the makers. These boats have a guaranteed speed of 25 knots an hour, and will be superior in their speed, carrying capacity, and equipment to any torpedo boats at present in the service.

Yarrow and Co., of Poplar, have built no war vessels of any class during the year for the British Government, their output consisting principally of their special types of vessels for foreign navies, which we describe later on.

At the Thames Ironworks shipyard, at Blackwall, the new battleships Duncan and Cornwallis, building for the British Government, are both proceeding well, but by no means so quickly as H.M.S. Albion at the start; their framing is, however, well advanced, more than 1440 tons and 1190 tons of material having been worked into them respectively. The Albion, still unfinished, it is hoped will be completed about the end of next March.

At the company's newly-acquired works in Greenwich—lately those of John Penn and Sons—the propelling engines of 1400 indicated horse-power for her Majesty's sloop Condor, building at Sheerness, have been put into the vessel and are ready for trial, which will take place during next month. Similar engines of the same power for the sister ship Shearwater—building in the same dockyard—are standing erected in the shops, and ready for fixing on board as soon as the vessel is launched, which is expected to take place at the end of next month.

The propelling engines of the first-class battleships Duncan and Cornwallis, of 18,000 indicated horse-power, are in progress, those of the first-named vessel—so far as the various parts are concerned—have reached an advanced stage, and will be soon in evidence in the erecting shops; while the materials, castings, and forgings for the sister ship's engines are well in hand, some of the work being already in the machines. Similar engines of like power for H.M. battleship Albemarle, about to be laid down at Chatham, have just been commenced, some of the necessary material having been obtained.

The last warship to be engined by the late old-established firm of John Penn and Sons, at Greenwich, her Majesty's battleship Goliath, is now completed, having satisfactorily passed all her trials, and will shortly be commissioned. The Pomone, third-class cruiser, built at Sheerness, and also engined by the Messrs. Penn, completed her trials early in the year, and was passed into the Fleet Reserve.

Maudslay, Sons, and Field, of Lambeth, will have the propelling machinery of her Majesty's ships Albion and Spartiate ready for steaming in about three months; that of the Irresistible being now fitted on board, the heavier parts being already in place. The machinery for the battleship Venerable is being now erected in the shops at Lambeth, and is fairly well advanced.

Humphrys, Tennant, and Co., of Deptford, have fitted the machinery of the new Royal yacht on board during the year, and the vessel is now ready for her trials. The firm's shops have been busily engaged with the propelling engines of 30,000 indicated horse-power for the armoured cruiser Drake now building at Pembroke, and have made fair progress with them. These engines are the first of their size ordered by the Government.

Of the West Coast shipbuilding firms, Laird Brothers, at Birkenhead, have completed for sea the first-class battleship Glory, built and engined by them, she having left the Mersey on December 9th for Portsmouth, where she is now preparing for her official trials. The battleship Exmouth, of the Duncan class, ordered in January last and laid down in the building dock vacated by the Glory last March, has made good progress, and is now framed up to the protective deck. The single-screw sloops Mutine and Rinaldo, of 980 tons displacement and 1400-horse power, are now nearly ready for launching, and their machinery is in a forward state. The engines of 15,000 indicated horse-power for the first-class battleship Implacable have been completed, and are being shipped to Devonport for erection on board the ship.

The 30-knot destroyer Orwell has been completed, satisfactorily passed through her trials, and delivered over to Devonport Dockyard. The Lively and Sprightly destroyers, also 30-knotters, are framed and plated. Laird Brothers having recently received the order for the machinery of the battleship Montague—now building at Devonport—which is to be of 18,000 indicated horse-power, the work has now been taken in hand. A set of new boilers for the Blanche have been completed and delivered at Devonport, and two water-tube boilers for Torpedo Boat No. 34 are now in progress.

Vickers, Sons, and Maxim, at Barrow, have the following warships in progress for the British Admiralty:—The battleship Vengeance—now approaching completion—has the whole of the structure of her hull and internal fittings finished and all armour, including casemates, in place. All decks are laid, bridges and deck-houses up, masts, fighting and search-light tops stepped. The auxiliary machinery, including the steering, windlass, capstan, and boat-hoisting engines and gear, with anchor gear and air-compressing machinery, are all in place and completed. The magazines and shell-rooms are lined and fitted, and the ventilating system, electric lighting, telegraphs, &c., are practically completed. The main propelling engines and all the boilers are now in place, and it is expected to have steam up in about a couple of months.

The steel work for the first-class wood-sheathed armoured cruiser Hogue is well advanced, and part of the armour in place. The fitting up of the shell and store rooms, and the magazines, is being proceeded with; the outside sheathing is also well advanced, and the vessel will soon be ready for launching. The work on the sister ship, the Euryalus, is being rapidly pushed forward, the hull being framed up to the protective deck, and partly plated. The King Alfred, first-class armoured cruiser, is in frame to upper deck; and the Vixen, 30-knot destroyer, is all framed, and the plating of hull and decks is in a forward state.

The foreign warship constructions in English shipyards, completed and in progress within the passing year, include the following:—

Vickers, Sons, and Maxim are building a first-class battleship named the Mikasa, for the Imperial Japanese Navy; the steel work of which vessel up to the protective deck is three-fourths finished, and the framing above the deck is well in hand.

Laird Brothers have built and completed the 30-knot destroyer Som for the Russian Government. This vessel is very similar to the British boats of the same class, and is now undergoing her trials. They have also thoroughly overhauled the hull and machinery of the Argentine Government transport Guardia Nacional.

Hawthorn, Leslie, and Co. have supplied the machinery for the United States cruiser Albany, built at Elswick, the vessel being now ready for her trials; and have in hand that for two coast defence battleships for the Norwegian Government—also built at Elswick—the machinery for one of these vessels—which are to have Yarrow boilers—being completed in the shops, and the other well forward.

J. I. Thornycroft and Co. have delivered during the year four of six 30-knot destroyers ordered by the Japanese Government; the last of the six is rapidly approaching completion. For the French Government they have building two shallow-draught river gunboats, very similar to the Woodcock and Woodlark, built for the British Navy. The vessels are powerfully armed, protected with bullet-proof plating, and will steam fifteen miles an hour on a water draught of 2ft. Two large steel lighters of the same draught are being built to serve as tenders to the gunboats for the conveyance of stores, troops, &c.

Yarrow and Co., during the present year, have delivered five of the six destroyers ordered for the Japanese Government, and are now proceeding with the official trials of the sixth. These vessels are all twin screws, with engines of 5800 indicated horse-power, their speed being 31 knots an hour. There has also been delivered from the Yarrow Works two sea-going torpedo boats for Austria, which have engines of 2000 indicated horse-power, and a speed of 24 knots an hour. The shipyard and shops are now busy with nine first-class torpedo boats for the Japanese, and five similar vessels for the Dutch.

Fig. 2 STRONG ROOM FOR THE PHILADELPHIA SAVING FUND SOCIETY

ARMOURED TREASURE VAULT.

UNDOUBTEDLY America is the land for novelties on a large scale. If the following is not a big thing, we do not know what is. Any reader looking at the engraving above may perceive that it is a circular door, with a remarkable development of lock, opening into a case or safe, but it needs very distinct telling to make him accept the fact that this circular door is 7ft. 3in. in diameter, that the door is itself a Harveyed or Krupp process armour plate, 8½in. thick, weighing 6 tons 17½ cwt., reinforced by a cast steel plate weighing nearly 3 tons 7 cwt. This 10-ton door opens into an armoured vault 16½ft. by 9½ft. The walls are described as half a foot thick, and 20 per cent. stronger than the Brooklyn turret armour. The story of the evolution of this armoured vault is related as follows:—

Up to the present, so-called burglar-proof vaults, like many supposed fire-proof buildings, have failed when put to the test. The skill of the burglar has been challenged with every successive improvement in vault construction, and he has, with the assistance of such agencies as dynamite, nitro-glycerine, &c., been able to demonstrate that safes or vaults constructed in the usual manner of five-ply welded steel and iron, or a combination of railroad iron, &c., can be broken within a night's time.

Bankers are so thoroughly convinced of this, having obtained the knowledge at a great cost, that they, in their desire for protection, have felt constrained to adopt the questionable expedient of placing greater reliance upon watchmen, electrical alarms, and such makeshift safeguards than on the strength of their vaults for the safety of the contents between business hours. An analysis of this makeshift protection will convince the thoughtful mind that it is open to objections. First, that the watchmen in charge of the bank or of the electrical alarms may be overcome by superior force. Secondly, that the elements may render the electrical alarms useless. Thirdly, collusion between the watchmen and those in charge of the electrical alarms with thieves would place the treasure, so far as these questionable safeguards are concerned, at the mercy of these gentry.

As the construction of such means of protection by five-ply welded steel and iron, railroad iron, &c., has proved unsatisfactory, the investigation of armour plate for this purpose was begun for the purpose, if possible, of finding a material which would resist any known cutting instrument, as well as concussion from large quantities of nitro-glycerine, dynamite, &c.

It was found that armour plate, made in accordance with United States Government specifications, fully met every requirement. The next important question to be determined was how to join these plates together independently of screws in a manner to utilise the strength of the material at all points. This problem has been solved by the patented methods of construction by Hollar and Kennedy, Philadelphia, whereby all plates are united by the dovetail method, each plate supporting and resisting the displacement of the others, as shown in Fig. 1.

The largest plate to be used in the vault will weigh 28,000 lb. The largest laminated plate used heretofore weighed 3000lb. English vault builders have hitherto held aloof from the use of laminated metal, but have recently adopted re-forged Harveyed nickel steel armour plates for special work. In 1894 the United States Government appointed a Commission to investigate the subject of vault and safe construction, and this Commission reported that absolute security cannot be obtained by the use of laminated plates bolted together. The vault above mentioned is being constructed for the Philadelphia Saving Fund Society. The plate was tested by machine drilling so as to give hold to a large charge of dynamite, which was exploded without effect, while a laminated steel plate was completely wrecked by the same test.

The vault will be used for safe deposits, boxes for individuals, corporations, and banks. Double-movement locks will be fitted on each box. An officer will be present during business hours, and will carry a master key, which must be turned in the lock, and then the owner completes the opening by means of a different key. We think that the following claim may be conceded:—

"Pittsburgh will soon have the most impregnable repository in the world for the safe keeping of wealth and valuables. Its capacity to resist attack and destruction by burglar or mob force will be almost infinite. Compared with the great vaults of the Bank of England and the United States treasury department, the one now proposed will afford more security, and will be as far in advance of these vaults as they were ahead of the primitive strong box of wood."

How far banks and business men in this country may think the money spent on security against fire on a large scale, and mobs armed even with mining explosives or field guns, a good investment, remains to be seen. We have no idea of the cost of this armoured vault, but we presume that the information could be obtained at Messrs. Carnegie's offices in William-street.

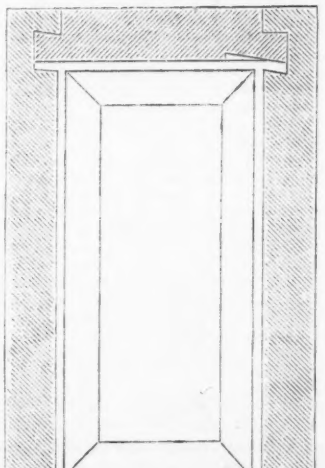


FIG. 1.

A CHRISTMAS EVE FESTIVAL.—On December 23rd. Mr. Jardine and Mrs. Jardine entertained in the Meadows Hall, Nottingham, about 750 of the children of the workpeople employed in Mr. Jardine's factories.

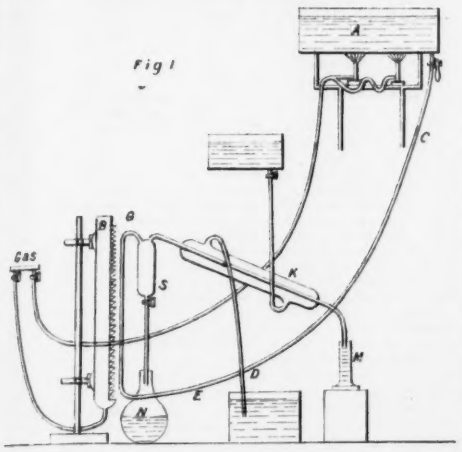
INSTITUTE OF MARINE ENGINEERS.

THE INFLUENCE OF VELOCITY ON EVAPORATION IN TUBES.

ON the 11th inst. the following paper on "Experiments showing Decrease in the Rate of Evaporation in consequence of Increase in the Rate of Circulation through the Tubes of Water-tube Boilers," by Mr. Geo. Halliday, member, was read:—

Former experiments were made to see whether molecular change of the water was the cause of the increased absorption of heat by water at the boiling point. We found that at the boiling point there was rather less absorption of heat than at lower temperatures. This was the condition of things when the effects of more rapid motion of the water were eliminated. An attempt was also made to find whether there was a constant increase of absorption of heat by the water as the speed of the water through the tubes increased. It was found that the absorption of heat did rise with an increase of velocity up to a certain point, but after that point in the velocity was reached the absorption fell off, and continued to fall off as the speed of the water continued to increase through the tube. This point in the speed of the water where the maximum rate of absorption of heat occurred was not a fixed point. It varied under the influence of various factors. The speed at which the maximum effect took place rose as the quantity of heat supplied to the tube increased. So did the quantity of heat absorbed rise. The quantity of heat absorbed rose also with the quantity of heat supplied to the outside of the tube.

In these experiments we only treated with water. We did not deal with water and steam. The moving water was not evaporating steam when the results were noted. That being so, it would not be fair to conclude that water while evaporating behaved in the same way as water did under changes of velocity. Water, while evaporating steam, might behave quite differently to water alive without steam. Water when evaporating steam does not run through the tube as water, but as water and steam, and therefore the effect of the presence of the steam may change entirely the conditions. What was sought in the following experiments was to apply heat to the outside of a tube through which water was flowing, and to note the quantity of steam given off while the water was moving at different velocities. The quantity of heat was also varied, and the quantity of steam given off under the different conditions was noted. First of all, it may be premised that the accepted view is that the evaporation increases with the rapidity of circulation of water through tubes: that is, the faster



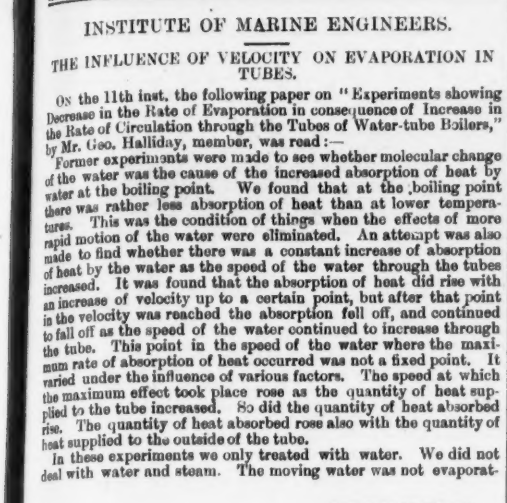


Fig 2.

the water runs through tubes, it is believed the quicker is the evaporation of steam. Professor Perry even goes the length of saying that the water might be forced quickly through with a force pump. John Elder designed a boiler on this principle. This is the universal view with one exception. THE ENGINEER has held that this is not true. It has always held that circulation is an evil, after a certain point. It says, "So long as the surface is wetted, so long as the circulation is sufficient to provide a wetted surface, that is enough. Anything beyond that is injurious." I do not know that any experimental proof has been given to demonstrate this. My belief is that it is a conclusion drawn by engineering instinct, led up to by watching the action of water on surfaces. However that may be, the statement was made that circulation after a certain point is injurious.

The experiments were made with water heated in a tank A—Fig. 1—to the boiling point, and made to flow through a tube heated with a Fletcher burner B. When it had flowed through the tube, and got heated, the steam was separated from the water in a separator, and each separately measured.

First the fire of the Fletcher burner was kept constant; that is, the heat supplied was kept constant. Under this condition it was sought to determine the influence of the rate of circulation. The rate at which the water moved through the tubes was varied. It was sought to determine whether the amount of evaporation remained constant with the heat supplied, or varied with the velocity of the fluid through the tube.

The second question was whether the evaporation increased with the speed of the water and steam through the tube, or in what way the evaporation was affected by the velocity of the water and steam through the tube.

First then, the tank supplying the water was heated until it gave off steam freely. Then the Fletcher burner was lit and the flames allowed to play on the copper tube G. Then the water from the tank was turned on and allowed to run. After the water had gone through the heated part of the tubes, steam and water together flowed through the separator S into the flask N. After that the cold water was turned on at the cold water tank and made to flow through the condenser K. By that time the whole apparatus was in full working order.

The time settled on for each experiment was four minutes. At the end of four minutes the water was measured and the condensed steam measured also. The sum of the two gave the quantity of water which flowed through the tube for four minutes, and the quantity of steam evaporated for four minutes. After the first four minutes 14 cubic centimetres of water were found in the measure. This meant that 14 cubic centimetres of water had been evaporated during the same time that 175 cubic centimetres of water had flowed through the tube without having been evaporated. This quantity, 175 cubic centimetres, was found at the end of the first experiment in the flask. The total water which had flowed through the heated copper tube was thus 189 cubic centimetres.

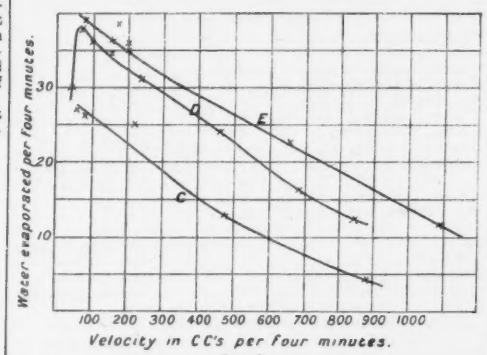


Fig. 3

When these had been measured, the water in each measure was poured away and the apparatus got ready for a second experiment. The flame and the gas supplied to the Fletcher burner were left the same as before. This flame was kept the same through the full set of experiments. To start with, the water and steam were allowed to run right through the separator. As soon as it was time to start, the water and steam were shut off in the separator by means of the small tap at the bottom, and the flask cleared out. When placed below the separator the water was run into it again, but a little water was always left in the bottom of the separator to prevent steam blowing through. The steam then flowed through the second branch at the top of the separator, got condensed and flowed into the measure. At the end of the four minutes the condensed steam was measured and the water also. The result of the second experiment was that at the end of four minutes 18 cubic centimetres of steam had been condensed and 140 cubic centimetres of water had run into the flask. The total quantity of water which had flowed through the copper tube was thus 158 cubic centimetres.

The results of the sets of experiments were as follows:—

Velocity of water.	Water evaporated.
93½	23½
94	24
103	23
121½	21½
129	19
158	18
189	14

In the second set we have:—

Velocity of water.	Water evaporated.
54½	24½
93	23
122	22
378	18
575	15
664	14
762	12

In the next set of results more heat was used at the Fletcher burner. Care was taken to begin with a large velocity and then gradually work down. The object was to see whether the very slowest rates of motion were followed by the greatest evaporations, or whether it was best to have some velocity. The results appeared to show that there was a maximum evaporation at a certain speed of the water. That, at very slow speeds, the evaporation was a certain amount, at higher speeds it was greater, and there was a maximum. The figures and curve D show how the evaporation varied with the speed.

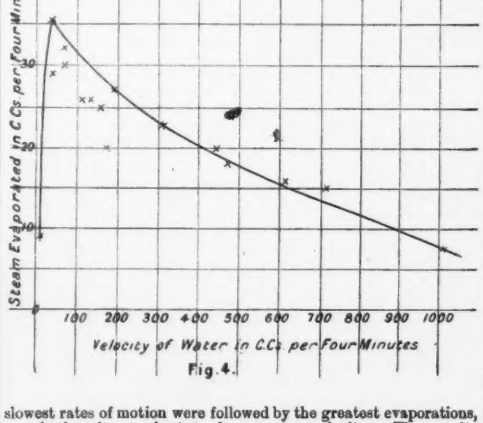

Steam Evaporated in C Cs per Four Minutes
30
20
10
0
100 200 300 400 500 600 700 800 900 1000
Velocity of Water in C C's per Four Minutes

Fig. 4.

Time.	Water evaporation.	Water not evaporated.	Total water flushing.
7.47 to 7.51	12	830	842
7.52 „ 7.56	16	665	681
7.58 „ 8.2	31	190	221
8.3 „ 8.7	34½	110	144½
8.8 „ 8.12	36	62	98
8.13 „ 8.17	38	28½	66½
8.21 „ 8.25	30	10	40

The fire from the burners was then turned full on and no attempt was made to see whether there was a velocity which gave a maximum evaporation.

The result is given below, and the curve representing the results by E, Fig. 3.

Time.	Water evaporation.	Water not evaporated.	Total water flowing.
8.24 to 8.42	40	36	76
8.29 „ 8.33	86	123	156
8.34 „ 8.38	35	170	205
8.39 „ 8.43	22½	635	657½
8.44 „ 8.48½	11½	1080	1091½

An addition of heat appears simply to raise up the curve that is to increase the amount of evaporation. The curves also appear to show that a velocity which gives an evaporation about equal in quantity to the water not evaporated gives the best result.

The above results were obtained by experimenting with the same copper tube throughout.

The following results of experiments were made when using a tube of larger internal diameter. The time of each experiment was, as before, four minutes. The period noted for the water to run through the tube was four minutes. The water was brought to the boiling point in the tank first, so that the flame had to deal with boiling water. The steam was separated from the water in the same way as it was separated in the former experiments. The totals in the fourth column represent the velocity of the water, and the second column the evaporation.

Here follows the results of experiments:—

Velocity.	Evaporation.
12	10
37	29
40·5	35·5
68	32
71	30
106	29
106	31
130	26
155	25
175	20
197	27
308	23
440	20
478	18
616	16
705	15
1007·5	7·5

It will be noticed that when the velocity is very small the evaporation is small. In these two cases the quantity of water supplied was insufficient, and the effect was simply to heat the pipe. The highest evaporation was when the velocity was 40·5. In that case the evaporation was 35·5. Really all the water supplied was evaporated, and the greatest effect took place then. In the case where the velocity was 68 the evaporation was 32. In this case the quantity of water evaporated was about equal to the quantity not evaporated, yet there is a considerable fall of evaporation from the maximum. It is, then, sufficiently shown that the quantity of steam evaporated depends on the quantity of heat supplied to the outside of the tube; and secondly, on the speed at which the water flows through the tube. The greater the speed of the water through the tubes of a water-tube boiler the less is the evaporation.

TRAMWAY FARES AND FRANCHISES.

FROM an interesting little pamphlet recently published in the United States, we take the following condensed statement as to the systems of traction, the fares and the franchises of tramways in a number of important cities:—

Basle, Switzerland.—Electric traction. All lines built, owned, and operated by the city. Fare, 1d. for short and 2d. for longer distances. Passengers allowed to stand in the aisles and on the platforms.

Belfast, Ireland.—Horse traction. Fare, 1d. per mile. Passengers not allowed to stand in aisles or on platforms. The company has a fourteen-year franchise, and paid no bonus, but has to pave and repair the middle of streets traversed by its lines.

Berlin, Germany.—Electric, steam, and horse traction, and an ordinary steam railway on an elevated belt line. Fares, 1½d. for two miles, and ½d. for each additional mile. No passengers allowed in aisles, but a designated number allowed on each platform. The companies have to pave and repair the streets through which their lines run, and to pay a substantial bonus to the city.

Berne, Switzerland.—Steam and compressed air traction. Fare, 1d. per mile. No one allowed to stand in the aisles, but a designated number on the platforms. The city is negotiating for the purchase of the company's lines.

Brussels, Belgium.—Electric—underground conduit and overhead wire—steam, and horse traction. Fares, 1d. to 6d., according to distance. No one allowed to stand in the aisles. The cars are generally divided into two compartments, first-class and second-class.

Buenos Ayres, Argentine Republic.—Electric, steam, and horse traction. Underground—conduit—electric line being constructed. Fares, 5d. and 10d., paper. Two postmen and one policeman allowed free on front platform, and three passengers on rear platform. The lines are owned by British companies, which pay 6 per cent. of their gross receipts to the city.

Calcutta, India.—Horse traction to be changed to electric traction. Fares, 1½d. to 2½d. No passengers taken on after all seats are occupied. Franchise, twenty-five years. The company pays a fixed amount per annum, and keeps the middle of the streets in repair.

Cape Town, Cape Colony.—Electric traction, overhead wires. Fare, 3d. for three miles. Passengers stand on the platforms, but not in the aisles. American cars. Franchise, twenty-five years. Company makes no payments to the city.

Christiania, Norway.—One electric line, five miles; one horse line, four miles. Other lines under construction. The city intends to buy the lines as the franchise expires, and is now building a short line as a public enterprise. Fares, 1⅗d. No passengers allowed to stand in the aisles, but fixed numbers on the platforms. The companies made no direct payment for their franchises, which expire in 1924, but pay taxes on their property like other corporations. The cars have seats on top.

Copenhagen, Denmark.—Horse and electric traction. Fare, 1⅗d. for any distance. Conductors are heavily fined if more passengers are carried than can find seats. The company pays the city a percentage of its gross earnings.

Cork, Ireland.—Electric lines. Fare, 1d. for any distance. Passengers not allowed to stand in aisles or on platforms. The company has an unlimited franchise, and pays nothing directly. It paves the middle of the street, and furnishes electric light to the city at reduced rates.

Dublin, Ireland.—Electric traction. Fare, ½d. per mile; minimum fare, 1d. Cars have seats on top, but passengers are not allowed in the aisles or on the platforms. The company pays the city £500 per mile per year for right of way, and also paves between the lines and one foot on each side. The franchise runs forty years, with the provision that the city may buy the line after twenty years, paying actual market value of machinery and plant. In case of disagreement as to price, the Board of Trade is to be the referee.

Edinburgh, Scotland.—Horse and cable traction, but will soon be all cable. Entire system owned by the city and operated by a lessee company. Fare, 1d. per mile, except on certain popular routes, where the fare is 1d. though the distance is longer than a mile. Workmen's tickets between 5 and 7 a.m. and 5 and 7 p.m., and 1 to 3 p.m. Saturdays; these are 1d. for the first two miles, and ½d. for each additional mile. No passengers are taken on after all the seats are occupied.

Florence, Italy.—Electric and horse tramways are owned by the

city and leased to companies. Fares, 1d. from suburbs to city, and 1½d. across the city. Company has a fifty-year franchise, and guarantees the city at least £2400 annual revenue, besides contributing £80 per year to a tramway employés provident fund, and £60 to a cabmen's society. Profits over 7 per cent. are divided between the city and the company. Passengers are allowed on the platforms but not in the aisles.

Frankfort, Germany.—Entire system—20 miles—being changed to electricity, and recently bought by the city for £110,000 down, and £15,000 per year for seventeen years. Fixed number allowed on the platforms, nobody in the aisles. Reduced rates to pupils of general schools, art and music schools, &c. Family tickets at reduced rates where the husband's income is not over £5 per month, a wife's not over £3, and no son over twenty-one.

Ghent, Belgium.—Electric traction. Fares, 1½d. for first-class, 1 ct. for second-class. Passengers allowed on platforms and in aisles. Franchise runs fifty years from January 1st, 1898, and provides for purchase by city; company pays city 17 per cent. of gross receipts, but not less than £772, which sum is deposited every January. Franchise fixes minimum wages of conductors and motormen at 3s. 3d. per day, and of workmen at 2s. 10d.; maximum day's work, 14½ hours in summer and 13½ in winter, with 1½ hours for meals.

Glasgow, Scotland.—Horse traction, 37 miles; electric, three miles. Entire system is owned and operated by the city, and is to be made electric by 1901. Fares, ½d. for first half-mile, 1d. for two miles, ½d. per mile additional. Longest route, six miles. No transfers given. The rule against taking passengers on when all seats inside and on roof are occupied is not observed.

Havre, France.—Electric trolley system. Fares, 1½d. first-class, 1d. second-class; passengers on front platform pay first-class fare, those on the rear platform pay second-class fare. Transfers, ½d. extra. Nobody allowed in the aisles. Franchise runs 50 years from 1893. Company pays the city 2½ per cent. of its gross receipts, but not less than £700 per year.

Kingston, Jamaica.—Electric traction. The city is divided into three sections, with a fare of 2d. in each, or 6d. through the three sections. Three front seats reserved as first-class, fare 3d. Tickets sold at reduced rates. Franchise runs 30 years. Company pays Government 4 per cent. of its gross earnings, and maintains its streets for 18in. on each side of tracks. Passengers allowed inside and on platforms. Market cars for people carrying produce are run before 9 a.m., and after 5 p.m.; fare 1½d.

Liverpool, England.—Electric and horse trams, and omnibuses, all owned by the city. Fares, 1d. for each stage, and 2d. for the three stages—four miles. Passengers allowed to stand inside and on the platforms.

Lyons, France.—Electric, steam, and horse traction. Steam locomotives haul trains of three cars. Fares, 2½. for first-class—cushioned seats—1d. for second-class. Fourteen persons allowed on each platform, but nobody in the aisles. Only one door in each car for entrance and exit. Company pays annual tax of £3200, and 10 per cent. of receipts in excess of £400,000. Franchise provides for purchase by the city after forty years.

Maracaibo, Venezuela.—Three horse tramway companies, the oldest paying 3½ per cent. per month profit on its capital. They paid nothing, directly or indirectly, for their franchises, which have five years to run. The rule against passengers standing is not heeded.

Marseilles, France.—Electric trolley system being installed on all lines. Fares, 1d. Company paves between the tracks and 14in. outside, and pays the city an annual fee of £3860. When the gross receipts aggregate £280,000, a further fee will be paid as follows:—£1544 for the next £40,000, £1930 for the next £40,000, £2316 for the next, and £2400 for every additional £40,000. Electric trains limited to four cars—118ft., and speed limited to 12½ miles per hour. Franchise expires in 1950, when the State becomes the owner of the tracks and property on the public domain. During the last five years of the concession, if the company fails to maintain its property in good condition, the State may seize the company's revenues and apply them to this purpose. The State may buy part or all of the rolling stock, tools, &c., at a valuation fixed by experts. After 1950 the State may require the company to remove the tracks, and restore the paving on any lines which the State deems it useless to operate. The State also reserves the right to purchase the concerns at any time. The price would be fixed by the net annual revenue of the seven preceding years, including the fees paid to the city. From this total would be deducted the net revenue of the two least prosperous years. The average for the remaining five years would be the amount of an annuity to be paid the concessionaires during each unexpired year of the revoked concession.

Mexico City, Mexico.—City cars drawn by mules. Suburban cars drawn by mules to the outskirts, and then by small American steam tramway engines. Animal traction to be replaced by electricity, but steam will be retained. Fares, 2½d. and 3d., according to distance; suburban fares, 6d. to 15d. Passengers are allowed in aisles and on rear platforms, but not on front platform. American managers.

Munich, Germany.—Electric, steam, and horse tramways, all owned by the city. A limited number allowed on each platform, but none in the aisles. Fares on horse cars, 1½d. to 3d., according to distance.

Naples, Italy.—Horse and electric tramways. Fares, 1d. on two back seats; 1½d. on cushioned seats; 1d. to stand on front platform, 1½d. on rear platform. Company has a fifty-year franchise, and pays a percentage of its net profits to the city.

Paris, France.—There are 33 lines of two-horse omnibuses, with 26 to 30 seats; 14 lines of three-horse omnibuses, with 40 seats; 3 lines of steam tramway; 23 lines of horse tramway; and 4 lines of compressed air and electric tramway. All are controlled by one company, which has an exclusive franchise running from 1860 to 1910. In 1896 the omnibus lines carried 129,000,000 passengers out of a total of 240,000,000. Cars and omnibuses have seats on top. Fare, 3d. inside, with transfer ticket, 1½d. on top and on platforms. No passengers allowed in the aisles.

Prague, Austria.—Electric and horse tramways, all owned by the city. Fare, 1d. Passengers allowed in the aisles, but not on the platforms.

Rheims, France.—Electric traction being substituted for horses. Fares, 1½d. for first-class, and 1d. for second-class, ½d. extra for a transfer. Number of passengers per car fixed by law. Franchise expires in 1945. It provides that from the net profits each year, the company is entitled first to receive 5 per cent. upon its invested capital, while the city is entitled to 25 per cent. on any surplus above the 5 per cent. The remaining surplus goes to the company, except that after it has carried three million passengers, the city is to receive 4s. 9d. for each additional thousand passengers.

St. Petersburg, Russia.—Horse tramways, single line. The principal line was bought by the city in September, 1898, and is being operated by it at a profit. It intends to purchase the other lines, and introduce electric traction. The cars have seats on top. Fares, 1½d. and 1½d. Though there are a dozen different lines, no transfers are given. Passengers are allowed in the aisles and on the platforms. The cars slow down, but seldom stop for passengers to get off.

Stockholm, Sweden.—Horse and steam traction. Fare, 1½d. Five persons allowed on the front platform, six on the rear platform, and ten inside. The company has a franchise running forty years from 1876, and is taxed 5 per cent. on its income.

Stuttgart, Germany.—Electric traction. Power furnished by an independent electric lighting company. Fares, 1½d. to 3d., according to distance. The number of passengers per car is fixed, but exceptions are made in case of storm, night cars, &c. The company pays the city 2½ per cent. of its gross income.

New South Wales.—Electric, steam, and cable tramways, all owned and operated by the Colonial Government. Fare, 1d. per mile. The laws against overcrowding are disregarded.

Toronto, Ontario.—Electric tramways. Fares 2½d., or 5d. after midnight. Tickets, six for 1s., or twenty-five for 4s. 2d. Tickets good from 6 till 8.30 a.m. and 5 to 6.30 p.m., eight for 1s. Sunday tickets, seven for 1s. School children's tickets, ten for 1s. Children under nine years—not in arms—half fare. Passengers allowed in the aisles and on the platforms. The company has a twenty years' franchise, with renewal for ten years. It pays the city £160 per year per mile of single line; also 8 per cent. of its gross receipts up to £200,000, and 10 per cent. above that amount. It is also taxed on its plant, poles, &c.

Victoria, British Columbia.—Electric tramway. Fare, 2½d. Passengers allowed to stand on the platforms and in the aisles. The franchise is for fifty years, for which the company pays nothing, either in the way of taxes or bonus.

Winnipeg, Manitoba.—Electric tramway. Fare, 2½d. Passengers taken in regardless of seating capacity. Franchise granted in 1893 for thirty-five years, without bonus or conditions, except that after eleven years the company must pay the city 5 per cent. of its gross earnings, and pave its track—and a width of 8ft.—uniform with the pavement laid by the city.

AUSTRALIAN NOTES.

(From our own Correspondent.)

THE new Coolgardie reservoir is in the Darling range, twenty-six miles from Perth. The catchment area comprises 569 square miles, and the reservoir will have a water surface of 672 acres, and a capacity of 4,600,000,000 gallons. It will be formed by constructing a cement concrete wall across the Helone River 700ft. long, and 100ft. high above the river bed, with a width of 50ft. at the top and about 85ft. at the bottom. The extreme height of the wall from top to bottom will in one place be about 200ft. The head to be overcome by pumps is 1350ft. static head, and 1150ft. friction head, total 2500ft. There will be eight pumping stations. The water will be conveyed through a main of steel pipes 30in. diameter. The works are designed with a view of delivering at Coolgardie, a distance of 325 miles, a daily supply of 5,000,000 gallons of water. The estimated cost of the undertaking is £3,000,000; it is suggested that a charge of 3s. 6d. per 1000 gallons will be ample to cover interest charges and maintenance. The present cost of water on the field is 8s. per 100 gallons. The principal mine at Kalgoorlie is paying at the rate of £8000 per annum for water.

A short time ago the Government's attention was brought to bear on the fact that in the N.S.W. postal department contracts for insulators an arbitrary clause was inserted that the articles must be made in Germany. This clause has now been eliminated.

One of the finest steamers in Sydney Harbour has just been placed in the ferry service between Sydney and North Shore. The boat is larger than any of the others in the service. Special attention has been paid to seating accommodation, and convenience of ingress and egress; the boat has been fitted throughout with electric light, which has not been stinted. Her engines are triple-expansion, 13in., 21in., and 34in. diameter by 21in. stroke; steam is supplied from two multitubular boilers, 7ft. 2in. diameter by 18ft. long. The run, which usually occupies 8 min., is accomplished by this boat in 3 min. 25 sec.

In consequence of the repeated delays in the completion of the George and Harris streets—Sydney—electric trams, a special board of inquiry was appointed to inquire into the reasons of the delay. The report of the members of the board—which consisted of Professor Warren, and Messrs. J. A. Pollock and B. Wallach—has proved very unsatisfactory. Briefly summarised, the points raised are as follows:—The methods of wiring behind the switchboard at the power house are not in accordance with the best practice, in view of the risk from fire. The junction feeder boxes have not the required insulation. Much greater electric power has been provided than was at first contemplated, and the time for the completion of the work has been correspondingly greater. The second cause has been the alteration of the unit from 800 kilowatts to 850 kilowatts, rendering it necessary to await the arrival of plans from America before it was practicable to proceed with the plans of the power-house building. A delay of six months occurred in this way. The board considers the delay in the completion of Stewart and Co.'s contract for construction of the power-house buildings is attributable to themselves, and their delay in finishing the setting of the boilers might have been avoided. So far as the board could ascertain, no steps were taken to inspect the machinery after it arrived here. One of the armatures was stored in a cellar, when a rainstorm caused water of a depth "sufficient to wet one's boots to lodge in the cellar." Another armature was wetted by rain falling on it while it was being pressed on the shaft. The generators were wet, as were also the shunt field coils. None of the generators have yet been tested to their full loads, because, until the generators are dry, they cannot be built up to voltage.

The board conclude their report by saying, "We have not been able to make the various tests specified for the engines and generators, as the plant is not sufficiently completed, nor in a fit state to admit of such tests; and, moreover, the limited time allowed for this inquiry would have rendered it impossible in any case to have included the results of these tests in our report."

The following rates are paid to men engaged in the undermentioned duties in the service of the New South Wales Government railways.

	Minimum rate per day.	Maximum rate per day.	General average rate per day.
	s. d.	s. d.	s. d.
Artisans, &c.:			
Patternmakers	10 0	16 0	11 6
Carpenters	8 0	14 0	9 7½
Carriage and wagonbuilders	8 0	12 0	10 0½
Moulders	9 4	14 0	10 4½
Blacksmiths	8 0	16 0	10 8½
,, strikers	6 0	8 2	7 3
Turners	8 0	12 8	10 6
Machinists	6 6	13 0	8 7½
Fitters	8 0	14 0	10 6½
Gas-fitters	7 0	12 6	9 7½
Tin smiths	7 0	12 0	9 11½
Boilermakers	8 0	14 0	10 0½
,, assistants	6 8	8 6	7 2
Painters	7 6	12 0	9 2
Railway Operatives:			
Locomotive engine-drivers	11 0	15 0	13 8
,, firemen	8 0	10 0	9 6
,, cleaners	2 6	10 0	5 3½
Stationary engine drivers	6 6	12 0	8 3½
Fuelmen	6 6	3 6	7 1½
Pumpers	6 0	10 0	8 2½
Examiners (carriage and wagon)	7 0	13 0	9 4½
Oilers	4 0	8 0	6 7½
Gangers	8 6	12 0	8 11
Fettlers and labourers	6 0	9 0	7 0½
	Per annum. £ s. d.	Per annum. £ s. d.	Per annum. £ s. d.
Stations masters	150 0 0	400 0 0	214 10 4*
Officers in charge	130 0 0	220 0 0	150 0 9½*
Night officers	120 0 0	185 0 0	134 14 9½
Traffic clerks	125 0 0	500 0 0	195 10 6½
,, junior	30 0 0	120 0 0	82 18 5½
Telegraph operators	60 0 0	200 0 0	124 7 8½
	per day. s. d.	per day. s. d.	per day. s. d.
Signalmen	7 0	11 6	9 2½
Porters	6 0	10 0	7 0
,, juniors	2 6	5 0	3 10½
Shunters	7 0	11 0	7 8½
Guards	8 6	12 0	9 11½
Assistant guards	8 0	8 6	8 4½

* Allowed free houses.

AT a special meeting of the Ardsley Urban District Council it was decided to adopt a scheme for the bacterial treatment of the sewage of the Hoyle Mill and Measbrough Dyke portion of their district.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Belt conveyors.—Belt conveyors having belts of india-rubber are being used to a considerable extent for handling materials of various kinds, many of which it would seem at first almost impossible to handle economically in this way. The Robins system is specially designed for such work, and its belts are vulcanised in a special press 50ft. long. All the pulleys, brackets, grease cups, and other metals parts are made to gauge by automatic machinery, and are interchangeable. To form the running side of the belt into a trough, special brackets carry one horizontal idler or roller, and two inclined idlers. Hollow shafting is used, into which grease is forced by compression cups, and works out through holes in the shaft into the bearings. The bottom idlers are horizontal, and and guide idlers are used where required. The body of the belt is formed of layers or plies of cotton duck, covered with a patented rubber composition, the rubber being made much thicker at the middle of the carrying side than at the edges. The edges are stiffened by turning over some of the cotton duck layers at the edges. The material is soft and exceedingly tough, will stand bending over the end pulleys and by the side troughing pulleys, and will stand the wear of broken stone, ore, and other sharp and heavy substances. One of the dredges on the Danube River has a 36in. Robins belt running at 550ft. per minute on a conveyor 70ft. long. This carries the blasted and shattered rock from the dredge buckets to the shore. In the United States these conveyors are used for carrying zinc ore, broken stone, road metal, copper pyrites, coal, slate, gravel, coke, &c. One belt has been in use for over three years, carrying broken zinc ore (rock), and is still in good condition after having carried 300,000 tons.

Dynamo driven by water jets.—Water-wheels driven by powerful jets are frequently used to drive dynamos for power-transmission plants, and a similar arrangement is now being used at Columbus to drive an electric light plant. The pumping station of the city waterworks has an excess capacity, and the surplus water is now being utilised to drive a plant for lighting the neighbourhood by arc lamps. The dynamo is an arc machine of 100 lights capacity, and runs at the high speed of 650 revolutions per minute. There are six wheels, 18in. diameter, with buckets attached to the rim, and each driven by three jets. Each unit develops 110-horse power. The use of contracting nozzles to keep up the efficiency at light loads was prohibited by their cost and complication. Ordinary butterfly valves were used instead, and the cam mechanism operating them was so arranged as to operate them one after the other, instead of simultaneously. Thus the low efficiency of a partly-closed butterfly valve would have an almost inappreciable effect in lowering the total jet efficiency of the machine. The small diameter of the water-wheels, rendered necessary by their high speed, so far reduced their momentum that it was necessary to add a heavy fly-wheel, in order to keep the variations of speed within the guaranteed limits. The high speed also prohibited the use of the ordinary cast iron wheel, and the fly-wheel is therefore made with a steel rim shrunk on to a cast iron web. The governor operates six cams, the connection between the governor and the cam shaft being by means of gearing. The water chambers were cast in two pieces, the nozzles being bolted on. These castings were bolted to the cast iron base, and over them is a steel hood or cone, the upper part of which has eye bolts to facilitate removal. A vertical pipe has a large T head, from which rise six pipes with elbows, bringing them horizontally into the sides of the water chamber. On one of the shafts are the fly-wheel and dynamo, while at the other end are the governor and the valve-actuating mechanism.

Steel lighthouse.—The entrance to the Sturgeon Bay Canal, on Lake Michigan, has recently been protected by a cylindrical steel lighthouse, whose tower is 91ft. high. It rests on a concrete foundation 8ft. deep and 29ft. square, near the bottom of which are embedded eight sets of steel channel bars, to which the anchor bolts are attached. The base of the tower has eight trussed buttresses or braces, 16ft. 6in. high, and 6½ft. wide at the bottom. The back of each is riveted to the tower, while at the toe is one of the 1½in. anchor bolts. Four steel guy cables run from the top of the tower at an angle of 60 deg. The tower shell has courses 5½ft. high, of plates 12½ft. long and ½in. thick, set alternately inside and outside. This shell is 8ft. diameter. In the centre is a 24in. tube of ½in. steel plates, and an iron spiral stairway is fitted between the two shells, with cross braces at intervals. On top of the main cylinder is the watch-room, 11½ft. diameter and 7ft. high, with four 12in. port-hole windows. On top of this is the lantern, 8ft. 9½in. diameter. The glass interior section for the oil lamp is 6ft. high and 8ft. 8in. diameter. The light, which is of the third order, shows a flashlight alternately red and white, and is visible under favourable conditions at a distance of 18½ miles. The mechanism which operates the flashing apparatus is a train of clockwork operated by a weight which hangs in the central tube of the tower. Around the base of the lantern is a narrow gallery. The stairs are castings, each made in a single piece, and bolted to the two shells. This structure is representative of a new type of lighthouse favoured by the U.S. Lighthouse Board on account of its cheapness, simplicity, and durability.

Marine notes.—The Holland submarine boat has again been tested by Government officials with satisfactory results. Submerged 10ft. it made the measured mile in nine minutes, and with the surface flush with the water it made eight miles an hour against the tide. From 10ft. depth, it rose, discharged a torpedo and sunk again in ten seconds, the torpedo passing within 25ft. of the target flag. When submerged, it turned through half a circle of 75ft. diameter in one and a-half minutes. This vessel was built in 1896, and is of the so-called cigar shape, 50ft. long, and 9ft. diameter at the middle. Contracts have been placed for six new cruisers of the "Denver" class, six firms getting one vessel each, and all to be built to the original plans, all proposed modifications by the builders being rejected. The contracts amount to £1,234,000 in all. The new naval programme to be submitted to Congress calls for three armoured cruisers of 13,000 tons, three protected cruisers of 8000 tons, and twelve sea-going light-draught gunboats of 900 tons. all are to be sheathed and coppered, and will cost 5,200,000 dols., exclusive of guns and armour. The battleship Kentucky made an average speed of 16·88 miles per hour on a trial trip of 66 miles, the speed reaching as high as 17·25 miles on the run. The ship made a complete turn in three times its length, with a list of only three degrees. Under forced draught the coal consumption was 32 lb. per hour per square foot of grate surface, there being thirty-two boilers with 684 square feet of grate surface. The Detroit Shipbuilding Company is building a lake cargo steamer 430ft. long, 50ft. beam, and 28ft. deep, fitted with triple-expansion engines. In a three day's test of the Lidgerwood system of coaling ships at sea by means of an aërial tramway or cableway secured to the masts of the collier and the warship, the collier Marcellus delivered to the battleship Massachusetts 20 tons of coal per hour. The sacks of coal weigh 410 lb. each, and 126 were transferred in 66 minutes, and 88 in 44 minutes. The work was done in the open sea.

New cruisers.—The Navy Department has awarded contracts for the six new cruisers of the Denver class, the contracts being distributed among six firms, at prices averaging from £190,900 to £213,000, and aggregating £1,234,000. Tenders were received upon the department plans, and upon the modified plans submitted by the bidders, but all the latter were rejected, and the vessels will be built entirely upon the original plans. They are sheathed, protected cruisers, with triple-expansion engines, twin screws, two funnels, two pole masts, with 7150 square feet of sail area, flush upper deck, and bilge keels. The sea speed is to be 16½ miles per hour, and a bunker capacity of 700 tons. This is sufficient for 2500 miles at full speed, or 7000 miles at an economical 10-mile speed, so that they can go from San Francisco to Manila without coaling on the way. There is an inner bottom 264ft. long, and 135 compartments in the hull. The protective

deck will be ½in. thick, with 2in. of nickel steel armour on the side slopes. A straight "steamer" bow will be used instead of a "ram" bow. The sheathing will be of 4in. pine, covered with copper, and along the water-line will be a chamber fitted with corn pith cellulose. The length will be 308½ft. over all; on water-line, 298ft.; beam, 44ft.; freeboard, 16ft. to 20ft.; mean draught, 15½ft.; displacement, 3200 tons. Each main engine will have an 18in. high-pressure cylinder, 29in. intermediate cylinder, and two 35½in. low-pressure cylinders, all of 30in. stroke. The collective power will be 4500-horse power. Steam will be supplied by six water-tube boilers, with 13,000 square feet of heating surface, 300 square feet of grate surface, and 275 lb. working pressure. The main battery will consist of ten 5in. guns, eight in recessed ports on the gun deck, and one forward and one aft on the main deck, protected by shields. There will also be eight 6-pounders, two 1-pounders, four Colt automatic guns, and one 3in. field gun. There will be a distilling and refrigerating plant, ice machine, electric light, and ammunition hoists and winches, and boats enough for the full complement of 263 men and 27 marines. The vessels can carry 450 men comfortably.

Piecework in machine shops.—For piecework in railway shops, as elsewhere, the prices should be based on thoroughly competent workmen, and the standard of the men elevated as much as possible. They should also be based on the full capacity of the machines, where the holding-back practice is not resorted to. It will then be found that the ordinary or slow man will get into line with the rest. If this is not done, and the price is based on the medium workmen, the standard of the shop and of the best men will be lowered. This subject is now one of great interest in railway and manufacturing shops, and was the subject of a paper presented to the Western Railway Club by Mr. Shea, in charge of the piecework system of the Chicago, Burlington, and Quincy Railroad. In one particular case, the men in a manufacturing shop are averaging 16s. 8d. per day, while the day rate was 9s. 4d. It is found, however, that the great increase in output and reduction in cost per piece have made the piecework system a very profitable investment. One incidental but important advantage is that the men are inclined to remain permanently in the employ of the firm, and there are rarely any resignations. Under the day work system, however, there is always more or less of a tendency of the men to shift from place to place. The differential rate system is not generally approved, but when prices are once established they should not be varied in the shops, according to the ideas of individual foremen or inspectors, but should be changed only from the office. If the men know that too much work means that prices will be cut, they will keep within a limit. But if they know that no change will be made unless conditions change by improved machinery, &c., then they will work the machines and the plant to their full capacity.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

As the end of the year approaches, iron consumers are pressing for deliveries in every direction, and manufacturers despair of being able to satisfy their requests. The greatest difficulty in the way at date is the block of traffic on the railways. Ironmasters can neither get deliveries of coal, coke, nor pig iron in anything like the needed quantities.

The buyers of coal now find that they will have to rise 1s. on lumps and 6d. on slack on New Year's Day, a resolution to this effect having been come to by the Cannock Chase Coalowners' Association. It is anticipated also that the Black Country coalmasters will put up prices to the same extent, though united action is not so spontaneous in the Black Country as on Cannock Chase, since there is no coalmasters' association for the regulation of prices in South Staffordshire like that which exists on the Chase.

Prices are this week well maintained at the advances announced a week ago. The manufacturers of unmarked bars adhere to last week's advance of 10s. per ton, thus bringing the price up to £10. The makers of small rounds, who have hitherto only charged 5s. extra on ¾in. have advanced the rate to 10s. The makers of marked bars retain £10 10s. as the rate at present, but by January quarter-day it is expected an advance will be declared of 10s. or 20s. per ton, and probably earlier than this.

The sheet iron trade is increasingly active, and more money is being asked. The demand by galvanisers for black sheets is heavy at £10 15s. for doubles, and some of them who sometime ago would not buy here because they could get cheaper sheets from South Wales are now stranded, and are only given the option of taking small parcels, and these at a margin of 5s. above the people who have kept their business to the Black Country.

In strip, tank plates, and stamping iron, there is a large amount of inquiry, and for constructive sections and wagon-building material the demand is heavier than can be entertained. Shippers have placed some good orders in merchant bars, rods, and angle iron.

Ironmasters are so pressed for deliveries that they are anxious to get mills and forges started immediately, but the men are earning such good wages that they are in no hurry to begin.

Pig iron is firm at, Staffordshire cinder forge, 70s. to 72s. 6d.; part-mine, 75s.; all-mine, 77s. 6d. to 82s. 6d.; best ditto, 90s. to 92s. 6d.; cold blast, 120s. to 127s. 6d.; Northamptonshire and Leicestershire, 73s. to 75s.; Derbyshire, 74s. to 76s.; North Staffordshire, 76s. to 78s. Demand continues excellent, and inquiries for supplies over the first half of next year are being pressed upon sellers in far larger numbers, and representing far larger quantities, than they at all care to entertain. Makers are disposed to sell only little iron between now and January quarter-day, being assured that prices will then be still more substantial than at date.

Steel is in large demand, and prices are booming at, Bessemer billets and blooms, £7 5s. to £7 10s.; best Siemens ditto, £7 10s. to £7 15s. Plating bars are inquired for at £10, but no deliveries are possible within six months, and billets are also unobtainable for a like period at £7 15s. offered. A special feature of the steel trade is that makers will only quote for deliveries to commence after June next, and buyers must take the risk of getting supplies between July and December, or nearly twelve months hence.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The holidays during the past week have so much interfered with business, the usual Tuesday's 'Change meetings—the chief markets both for the iron and the coal trades—being altogether struck out, that there is practically little or nothing to report, except that the continued serious depreciation in speculative brands of pig iron has driven whatever transactions are just now being put through into the hands of low sellers willing to take at least 5s. or 6s. below makers' quotations. In Middlesbrough iron especially excessively low sales have been made, but makers have not followed to any appreciable extent, except that there has been a substantial drop in makers' quotations for Scotch iron. Lancashire pig iron, and both Lincolnshire and Derbyshire brands, remain nominally unchanged.

The Lancashire coke makers have during the past week advanced their list rates for both foundry and furnace qualities 1s. 6d. per ton, quotations being now about 29s. 6d. to 30s. for best foundry cokes, and 23s. 6d. to 24s. for furnace qualities at the ovens.

The pig iron trade has been subject to occasional fluctuations, the most noticeable being in August, when in less than a fortnight some of the speculative brands dropped 10s. to 12s. per ton, and for a time also brought down the prices of makers. Taking the year all through, however, the tendency has been generally in the direction of a steady and, towards the close, of a rapid upward move, representing an advance of something like 25s. to 27s. per ton, the opening prices at the beginning of January being 53s. 6d., less 2½, for Lancashire foundry; 51s. 6d. net Lincolnshire; 53s. to 55s. Derbyshire; 53s. 4d. to 53s. 10d. Middlesbrough, by rail Manchester; 55s. to 55s. 6d. Eglinton and Glengarnock, Manchester docks; 47s. 6d. to 48s., less 2½, for Lancashire forge; and 47s. to 47s. 6d. Lincolnshire, delivered Warrington, whilst, when the maximum point was reached at the end of November, they stood at 79s. 6d., less 2½, Lancashire foundry; 76s. 6d. net Lincolnshire; 80s. to 82s. 6d. Derbyshire; 79s. 4d. to 80s. 4d. Middlesbrough foundry, by rail Manchester; with Scotch iron quoted 82s. 6d. to 83s. Manchester docks, and forge qualities 77s., less 2½, Lancashire, and 75s. 2d. net Lincolnshire, delivered Warrington. Although these prices are not quite fully maintained at the close, owing to the great depreciation in speculative brands, makers generally have not so far receded to any material extent.

In the manufactured iron trade makers have, perhaps, never before been so pressed with work in all departments. During the early portion of the year they were very cautious in officially moving up their prices, owing to the then continued keenness of both American and continental competition. This, however, gradually during the second half of the year absolutely disappeared, one noticeable illustration of this being afforded by the hoop iron trade. Lancashire, some years ago, did a very important export trade with the United States in hoops, probably approaching 30,000 tons per annum, which was, however, entirely swept away by the much lower prices at which American hoop makers were able to quote. During the second half of the year, however, American inquiries again came pretty freely upon the Manchester market, and some tolerably large orders were booked at good prices for delivery in the United States. In the wire rod trade much the same thing also happened. The foreign business, which had previously been cut up entirely by the low American and continental prices, has been recovered owing to the withdrawal from the market of American and continental competition, and Lancashire makers have been able to book large orders for shipment at very considerably advanced prices.

The various advances that have been put on during the year represent an aggregate upward move of something like £3 per ton on various descriptions of finished material; bars, which in January were quoted £6 10s. to £6 12s. 6d., rising to £9 10s. to £9 12s. 6d.; sheets, from £7 5s. to £11; hoops, from £7 and £7 5s. to £9 17s. 6d. and £10, delivered Manchester. Although during December business has shown some slackening, buyers not caring to purchase too freely at the full rates to which prices have been advanced, makers close the year in an exceedingly strong position, and most of them having their books filled as far on as March or April next, are quite indifferent for the moment about new business.

Steel prices at the commencement of the year did not move up quite so rapidly as in the iron trade, but generally business has followed on pretty much the same lines. Hematites have been temporarily affected by the fluctuations in the speculation markets, but during the year have advanced from about 65s. 6d. and 67s. 6d., less 2½, in January, to 90s. 6d. and 93s. as makers' quotations in December, representing an upward movement of 25s. to 26s. per ton. On billets there has been an advance of about £2 15s., the opening price being £4 15s., as against £7 10s. at the end of November. On all descriptions of finished steel, especially material for shipbuilding, structural work, and boiler-making, there has been an altogether exceptional pressure of demand, which has enabled makers to raise their prices for bars £2, and for steel plates 20s. to 25s.; the prices in January being £7 to £7 12s. 6d., and £7 15s. for bars, according to quality; and £7 12s. 6d. for common to £8 10s. and £8 12s. 6d. for boiler plates, with quotations at the close of the year £9 to £9 15s. for bars, and £9 2s. 6d. for common to £9 10s. to £9 15s. for boiler plates delivered in this district.

The coal trade has, of course, participated in the prosperous condition brought about by the general industrial activity. Prices for the better qualities have perforce followed to some extent the generally upward move in other descriptions of fuel, and have advanced 1s. 4d. to 2s. per ton. Common round coals have been in exceptionally pressing request all through the year, and with rather a shortness of supplies, if anything prices have gone up quite 2s. to 2s. 6d. on inland sales, 10s. 6d. to 11s. being got at the pit at the close of the year, as compared with 8s. 6d. in January last. With iron-making and other manufacturing requirements taking off all the supplies of common coal that collieries have had to offer, the position of coalowners was, of course, very considerably strengthened with regard to the usual contracts for gas coal and locomotive fuel. Early in the year an understanding was come to between the colliery owners in Lancashire and Yorkshire to hold out for a minimum advance over last year of 1s. 6d. per ton on gas coal contracts entered into during 1899, and this was firmly adhered to, some collieries, in fact, getting advances equal to about 2s. per ton. The basis rates at which contracts were placed were 9s. to 9s. 3d. for the common sorts, and 9s. 6d. to 10s. for the better qualities at the pit, as against 6s. 9d. to 7s., and 7s. 9d. to 8s. in 1898; and corporations and gas companies not only settled their various contracts with extraordinary promptitude, but in most cases bought where they could extra quantities to cover their fullest possible requirements, rather than run any risk in the market and having to pay still higher prices for extra supplies. The position was practically the same with regard to locomotive fuel contracts, Lancashire coalowners deciding not to contract with the railway companies except at an advance of 1s. 6d. over last year; and although some of the largest companies endeavoured to break through this by offering contracts at an advance of 1s. 3d. per ton, these were declined, and ultimately the railway contracts were placed on the basis of 8s. at the pit, as compared with 6s. 6d., at which they had been able to buy in 1898, whilst later on in the year advances of 2s. had to be paid for extra quantities where these were required.

The shipping trade has fluctuated somewhat during the year, but with supplies of common round coal not at all plentiful at the ports, prices have steadily stiffened, representing an advance of quite 3s. per ton, steam coals, which could be bought at the ports on the Mersey in January at 9s. 6d., readily fetching 12s. 6d. to 13s. at the close.

The scarcity of slack all through the year has seriously hampered the coke trade in restricting the production of this description of fuel, as owing to the impossibility of obtaining sufficient supplies of slack, manufacturers of coke have been unable to put in large numbers of ovens which would otherwise have been utilised to meet the very pressing demand that has been experienced all through the year for both furnace and foundry qualities. It is needless to say that under these conditions prices have moved strongly upwards, and have advanced quite 9s. to 10s. during the twelve months, furnace cokes, which in January were readily obtainable at 14s., getting up to about 23s. 6d. to 24s., best foundry cokes rising from 20s. to about 29s. 6d. to 30s. at the ovens.

Barrow.—There is great strength in the tone of the hematite pig iron trade this week, and business maintains a very satisfactory position, although the holidays are on and commercial men are for the moment to a great extent enjoying their Christmas. Makers are all very fully sold foward, and orders are still more plentiful than they are in a position to accept them. Makers, in fact, do not require to go into the open market to get new orders. They come to them in a fuller degree than they can possibly deal with them, the result is that quotations are very high, at 80s. per ton, net, f.o.b., for mixed Bessemer numbers, and in some cases even this price would not be accepted, as orders are so largely held for forward delivery and prospects of a continuance of good business are so good. Warrant iron remains depressed from reasons altogether outside of trade influences or considerations, and prices only at 72s. 2d. sellers, 72s. 1½d. buyers net cash. Stocks are more firmly held than they were, but it is believed when warrants assume a normal position stocks will soon be very substantially reduced. There are forty-seven furnaces in blast, as compared with forty-one in the corresponding week of last year.

Iron ore is in very full demand, and prices are firm at 16s. per ton for good average sorts, net at mines. Spanish ores are at 19s. and 20s. per ton, and are still being largely bought.

The steel trade is very actively employed, and orders are very largely held. The demand is brisk alike for heavy and light classes, but more particularly for the former in the shape of rails and plates, heavy sections of rails being at £7 per ton, and heavy plates at £8 per ton. Heavy steel castings are in very brisk demand, and minor classes of steel are in very full inquiry, orders being largely held in every branch of the trade.

Shipbuilders and marine engineers are doing a very active business, and although no new orders are reported local yards are greatly thronged with work, all of which is of a pressing character.

The most critical question of the moment is as to the coal supply. It is beginning to fall off, although the demand is increasing and prices are going up to a very considerable extent.

Shipping is busily employed, and there is a large export of pig iron and steel. Owing to the holidays, the usual shipping returns are not to hand this week.

A new company has been formed—the Barrow Griffin Iron and Steel Company, Limited, with a capital of £75,000 fully subscribed—to commence the manufacture of chilled wheels and castings at Barrow, on Griffin's patents. A site has been purchased from the Barrow Steel Company. The new company will produce chilled iron and steel from hard hematite locally obtained, and from Canadian charcoal iron, which will be imported.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

IN the Yorkshire colliery districts the present has been largely a week of "playing." The holidays have been taken advantage of by the railway companies with a view of getting rid of the blocks upon their lines and sidings. The congestion on the different local railways has been something phenomenal. Large works with collieries of their own have been unable to receive supplies, although their pits are only a few miles distant. Other manufacturers who have to rely upon coalowners for supplies have been in exactly the same position, the companies, owing to the lack of locomotives and the overcrowding of the lines, having been utterly unable to cope with the traffic entrusted to them. It thus comes about that the pits cannot possibly meet the demand made on them, and the railway companies can neither obtain new locomotives nor increase the facilities on their lines.

At the time the holidays commenced the prices of Barnsley house coal were at 10s. 6d. to 11s. per ton, but there was such a demand for supplies to serve over the holidays that best Silkstones were sold up to as high as 14s. per ton, and Barnsley as high as 13s. per ton. The hope this week is that the railway companies will be able to use effectually the holidays to lessen the difficulties which have troubled railway managers, manufacturers, and coalowners. There is talk, however, of another advance in house coal on the first day of January.

In the steam-coal trade affairs have been precisely similar, the demand for prompt supplies having been very urgent, and coalowners with coal to sell in the open market have obtained almost any prices they asked, provided they could guarantee for delivery. While the inland demand has been exceptionally heavy, the Humber ports have also taken very freely. For prompt delivery, Barnsley hard coal has easily fetched 12s. 6d. to 13s. per ton, and in some instances 14s. The foggy weather and the sharp days have caused gas coal to be in exceptional request, and here again the supply has fallen short of the demand. Coke is as much in demand as ever, and an intimation has been given for a further advance in price for the new year.

There is no doubt that had the large works been able to obtain adequate supplies of coal there would have been a very short cessation of work this year. In all the heavy departments, particularly in armour, shot, and shell, gun work, &c., there are more orders in hand than can possibly be got out without running the machinery day and night.

Considerable extensions are being made to existing collieries in South Yorkshire district. Several of the pits in the Rotherham locality are to be connected with the South Yorkshire Navigation Canal. The company, which recently opened out valuable beds at Grimethorpe, has obtained a large area of coal under the Hooton Pagnall and Frickley properties, at which shafts have been sunk. Perhaps even more important than the opening out of collieries, which are already producing more than the railway companies can handle, is the likelihood of several new lines being completed in the new year. One of these, the Dearne Valley Railway, is to extend from Shafton, near Cudworth, and connect the Grimethorpe and Houghton collieries with the Hull and Barnsley line. Another development is that of the Hull and Barnsley, by means of which Hickleton Main, Wath Main, and Manvers Main will be reached. Walter Scott and Co., railway contractors, of Newcastle, have the contract for the last line in hand.

NORTH OF ENGLAND.

(From our own Correspondent.)

SCARCELY any business has this week been done in any branch of the iron and steel trades, owing chiefly to the holidays, and in the pig iron market also, owing to the unsettled condition of the warrant prices. The way warrants have dropped this month has rather alarmed the generality of speculators, and their great desire has been to clear out; they have, therefore, thrown their iron upon the market to be sold at whatever price it would fetch, and in doing this a good many have been heavy losers, for prices of warrants declined 10s. per ton between last month and last week, though they have improved somewhat this week, for on Wednesday 63s. 7½d. cash was offered for Cleveland warrants. Producers are not regulating their prices by the fluctuations in the values of warrants, as they are undoubtedly very well supplied with contracts, and moreover they do not believe that the present state of the warrant market is in the least degree justified by the position and prospects of trade in general. The fall in the value of warrants has, on the contrary, been brought about solely by the operations of speculators, and is directly in face of prosperous trade both present and prospective.

Makers continue to ask 70s. per ton for No. 3 Cleveland G.M.B. pig iron, and have maintained this figure even when Cleveland warrants were offered at 61s. 9d. It is a price which is prohibitive, but that is just now not a matter of much moment to producers, as they are well off for orders, and do not care for the present to take any more. Small lots of No. 3 could be had for second hands, towards the close of last week, at 64s. 6d., but 65s. has been asked and paid this week for practically all that has been sold, since Cleveland warrants have risen 2s. upon last week's minimum. No. 1 has been sold by second hands at 67s. 6d.; No. 4 foundry at 65s.; and grey forge, mottled, and white at 66s. There is very little forge to be had, and buyers have great difficulty in getting even small lots. This is the chief reason why forge is actually dearer than No. 3. Mixed numbers of Middlesbrough hematite pig iron are quoted by makers at 80s. to 82s. 6d., but even the lower of these prices is far above what consumers will at present give, with West Coast hematite warrants so much cheaper. A good many of the furnaces in this district are working badly this week, because of the holidays and the short supply of coke; in fact, most of the furnaces are on slack blast, and some

are damped down. This will reduce the production, and lower the quality also of what is produced, so that next month the supply of forge iron will probably not be so short as it is at present.

Most of the manufactured iron and steel works are laid off this week, and demand is quiet; prices have not shown any change from last week's figures.

A review of the year's trade in the iron and allied industries of this district cannot but assume a very cheerful tone; all engaged in them acknowledge that business has been exceptionally active and prosperous. Indeed, there cannot be the least doubt that a more satisfactory year than that now closing has never been experienced for at least a quarter of a century. Manufacturers have all through the year been employed to the fullest limits of their capacity, and could have done considerably more if their plant had admitted of it, for they have had to refuse many orders, and at the close are considerably behind in the execution of their contracts. Prices have moved up at a great rate, and very satisfactory profits cannot but have been realised, notwithstanding that the costs of production have in all branches gone up very materially. The strong advance in selling prices has been the marked feature of this year's trade. In the previous two years there was no lack of work, but prices fluctuated to a small extent only; this year the advance has gone on without a break from the beginning to the end of the year, and now in some branches buyers have to pay half as much again as they had in January. At the same time the costs of materials and of labour have all increased. In respect to the latter, wages of Cleveland ironstone miners have during the year been advanced 23½ per cent.; those of blast furnacemen, 20½ per cent.; finished ironworkers, 12½ per cent.; millmen at the steel plate manufactories, 15 per cent.; steel smelters, 15 per cent.; and puddlers' rates have been advanced 1s. 3d. per ton, making the rate in the North of England 8s. 6d. per ton. The pig iron makers have also had the railway rates for the carriage of iron-making materials raised 13 per cent., these rates being regulated by the fluctuations in the realised price of No. 3 Cleveland pig iron over each quarter.

The output of Cleveland ironstone for 1899 is estimated at 5,700,000 tons, as compared with 5,730,413 tons in 1898, but more would have been raised if the ironmasters had been able to procure coke enough to re-start and work some of the idle furnaces. The importation of foreign iron ore, particularly Rubio, has considerably increased, over 1,260,000 tons having been received in the Tees alone, against 1,172,165 tons in 1898. Some years ago, when more hematite pig iron was used for rail-making purposes—practically none is used in this district for that purpose now—the import was larger by over a quarter of a million tons than is reported for the year now closing. Rubio ore delivered on this side has risen from 14s. 9d. to 21s. during the year.

The production of pig iron is estimated to have been about 3,200,000 tons, as compared with 3,198,626 tons in 1898, there being a slight falling off in the output of ordinary Cleveland iron, but an increase in that of hematite. Nearly 70 per cent. of the pig iron made by Middlesbrough furnaces has been ordinary Cleveland or basic quality, whereas the furnaces in the other parts of the district have, with three or four exceptions, been producing hematite iron. Out of 125 blast furnaces in the North of England, 97 have been in operation. Of the 125 furnaces, 86 are Middlesbrough furnaces, and of these 69 have been kept at work. Stocks of pig iron in makers' iron are believed to be practically exhausted, but no statistical information in respect to them is now procurable, and it is judged that they are extremely small, by the great difficulty that has been experienced in getting supplies during the last half year. Some of the consumers' works, in fact, have been almost stopped at times because of the delay in getting pig iron, and vessels have had to be detained until the iron was made. The way in which the stock in Connal's store has declined affords a criterion of the state of the stocks. The quantity of Cleveland pig iron held by them has declined 47 per cent. during the year, and that of hematite 70 per cent.

The exports of iron from the Cleveland district have this year been considerably the best on record; they will reach 1,340,000 tons, this being 20 per cent. more than last year, and 7½ per cent. more than in 1897, which previously held the top place in regard to exports. The year 1899 has been remarkable for the great expansion of the demand for pig iron on foreign account; fully 832,000 tons will have been sent, or 45 per cent. more than in 1898, but the coastwise deliveries will be 5 per cent. less than last year; Scotland having taken less, as during the latter half of the year Cleveland prices have been relatively dearer than Scotch. Prior to 1895, it may be remarked, the pig iron shipments from the district never in any year reached a million tons, and the increase during the last few years has thus been very heavy. The bulk of the increase oversea has been to Germany, Belgium, and France; Germany alone has had 541,000 tons, against 299,675 tons last year. This increase has in some measure been brought about by the very short supply of coke on the Continent, in consequence of which they could not produce the extra iron themselves and have had to obtain it from this district, after vainly endeavouring to get as much English coke as would make up for their own deficiencies.

Prices of pig iron have advanced strongly, and the average quoted rate for No. 3 Cleveland G.M.B. pig iron, which in 1898 was 42s., for this year has been 60s. 4d., a higher average than has been known for a quarter of a century. In one month—July—the average was no less than 71s. 6d., and the top quotation of the year has been 75s., or 31s. 6d. above the minimum which has been reported. The year closes with the price 10s. below the maximum, but it is still 50 per cent. above the minimum, which was at the year's opening. The average realised price last certified was 55s. 2·38d., whereas for the last quarter of last year it was 42s. 5·21d. Cleveland pig iron warrants have fluctuated between 44s. 5d. in January, and 75s. 1½d. in July, the present price being 63s. 9d. Manufactured iron and steel prices have risen very satisfactorily, thus iron bars are now at £8 15s., advance 52s. 6d.; steel rails £7, advance 47s. 6d.; iron ship plates, £8, advance 30s.; steel ship plates, £8, advance 25s.; steel sheets, £10 7s. 6d., advance 50s., the minimum prices being at the commencement, and the best at the end of the year.

At the West Hartlepool Steel Works, now owned by the South Durham Steel and Iron Company, Limited, the steel smelters have been locked out. Some two years ago the employers there established an eight, instead of a twelve, hours' shift, an experiment which has not been introduced at any other works of a similar character in the kingdom. It has been found, however, that the arrangement did not work well, and the masters desired to re-establish the old order of things. The men objecting, they received a fortnight's notice, which has expired, and the men, to the number of 120, are out. The steel millmen at the Consett Works will have their wages for the next quarter advanced 5 per cent. Their wages are regulated by the realised price of steel plates, and this has given them previously five consecutive advances each of 2½ per cent.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron market was closed from Friday until Wednesday morning for the Christmas holidays. When the market re-opened there was a brisk demand for warrants, some 25,000 tons being bought at improving prices. Scotch warrants rose about 1s. per ton over last week's prices, but the market subsequently became easier, and has now a somewhat unsettled appearance. Business has been done in Scotch warrants from 64s. 6d. to 64s. 2d. cash, and 65s. to 64s. 8½d. one month. Cleveland iron has sold in small quantity at 64s. cash, and 64s. 6d. to 64s. 7d. one month. Business was done in Cumberland hematite warrants from 72s. 0½d. to 71s. 8½d. cash, and 72s. 7½d. to 72s. one month

The consumption of pig iron at home has been large, there being no slackening of work since last week. All the furnaces were kept in full operation over the Christmas, but they will now be "hung" for the New Year holidays. There are 41 furnaces making hematite, 37 ordinary, and 5 basic iron, the total of 83 now in operation in Scotland comparing with 82 at this time last year.

There has been a further reduction of 4467 tons in the stock in Messrs. Connal and Co.'s Glasgow stores.

The shipments of pig iron from Scottish ports in the past week amounted to 4619 tons, compared with 3316 in the same week of last year. There was despatched to Canada 520 tons, India 60, Australia 220, France 30, Italy 500, Germany 358, Russia 500, Holland 140, Belgium 30, Spain and Portugal 200, China and Japan 200, other countries 661; the coastwise shipments being 1210 tons, against 1659 in the same week of 1898.

Prices of Scotch makers' iron are as follows:—Govan, f.o.b. at Glasgow, No. 1, 66s.; No. 3, 65s.; Wishaw and Carnbroe, Nos. 1, 78s.; Nos. 3, 74s.; Gartsherrie and Calder, Nos. 1, 85s.; Nos. 3, 80s.; Coltness, Summerlee, and Shotts, Nos. 1, 86s.; Nos. 3, 81s.; Glengarnock at Ardrossan, No. 1, 83s. 6d.; No. 3, 77s. 6d.; Dalmellington at Ayr, No. 1, 80s.; No. 3, 77s. 6d.; Eglinton at Ardrossan or Troon, No. 1, 78s.; No. 3, 75s. 6d.; Carron at Grangemouth, No. 1, 85s.; No. 3, 78s. 6d. per ton.

The finished iron and steel trades have been very busy up to the time of writing, but are now closing down for the new year holidays. The tone is very firm in both departments, and the makers report that the year now closing has been the busiest in their experience. It is also satisfactory to note that while the year is closing there is no abatement in the demand, and 1900 promises to show equal if not greater activity.

The coal trade has been extremely active this week. Fully a week ago it was known that the coalmasters and merchants had more orders on their books than they would be able to deal with by the close of the year. Within the last few days, however, the pressure has been greatly intensified by a fall of snow and the setting in of severe frost. It has been found quite impossible to meet the demand as it came in, and the Coalmasters' Association issued a notice that all quotations were withdrawn, and that prices would only be quoted and supplies afforded as the state of trade would admit. The shipments have been very good for the season, although not quite up to those of last week.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

AT the close of last week the state of the coal trade, steam and house, was unaltered; in all branches there was the fullest activity, and it was quite understood on 'Change, Cardiff, that after the holidays, on a resumption of business, it would be found as vigorous as ever, but that some days of comparative inactivity were certain. During last week one or two small quantities for the Cape realised 30s., freight at the same time touching 22s. 6d. Gossip on 'Change states that Welsh best steam realised £6 in South Africa, but this, perhaps, is under exceptional circumstances. This week has been of a broken character, and up to Wednesday evening little colliery work was done. The promise, however, of the future is gratifying, and the year is expected to open with the coal industry of Wales at its highest point, so far. I see by Federation returns just issued that the proportions of the Welsh coal industry are now larger than ever known; including officials, enginemen, and stokers, the total number of men now employed has reached 124,000. Out of this total 106,400 now belong to the Federation.

Last week shipments from all ports were very strong, Cardiff sending off big cargoes to naval stations, large towns, &c. Swansea despatched 50,000 tons coal and fuel, and Newport indicated great activity by its shipment of 74,342 tons foreign, and coastwise 17,500 tons. In all districts trade is of a healthy and vigorous character, and general satisfaction is indicated at the practical expression on the part of the coalowners in excluding all possible matters of discontent in relation with the men. The initiative of Sir W. T. Lewis in withdrawing notices is a great subject of comment, and the wish is heard in many quarters that it is preliminary to his return to the Sliding Scale Committee, which he originated.

The prediction of a coal famine is being discussed. This may be stated, that at no previous time has the demand been so great from various quarters, and for various purposes. Every industry is working at high pressure. Coke and patent fuel are in strong demand; house coal is in pressing request; the requirements of transport and naval services are considerable, and the drain upon the Welsh supply is telling. *Per contra*, it can be urged that the labour condition is equable and hopeful, that new collieries are opening out well, and that no hitch is occurring at the old. The natural inference is that abnormal demands will be met, that prices will be high, but no famine. The position of the coal market in Cardiff when the Exchange closed last week was strong and healthy, with little disposition on the part of owners to book much for January at existing quotations, the belief being general that higher will be certain.

Up to mid-week, this week, business at Cardiff docks was in a half-hearted state, and Stock Exchange and brokers' offices being closed there was little to report. The following, up to my despatch, are the latest quotations issued:—Best steam is quoted at 27s. to 30s., and seconds, 25s. to 26s.; drys, 20s. to 21s.; best steam smalls, 13s. to 13s. 3d.; seconds, 11s. to 11s. 6d.; inferior sorts, 10s. to 10s. 6d. Household coals are firmly quoted at 18s. to 20s. No. 3 Rhondda, 21s. to 22s.; brush, 17s. to 18s.; small, 15s. 6d. to 16s. 6d.; No. 2 Rhondda, 17s. to 17s. 6d.; through, 14s. to 14s. 6d.; small, 11s. to 11s. 6d.

At Swansea, up to despatch, the usual drop of quotations was not given on 'Change, and prices may be understood as remaining the same as last issued for the present, but certainly not in any branch unsettled, or with any other disposition than to harden and to advance. Iron ore has been coming in freely from Santander, Castro, Nordiales, and Bilbao to Cardiff, Newport, and Swansea. The latest rail shipment was from Cardiff in the form of 1900 tons steel rails to Penang and Singapore, and from Newport a quantity to Somersetshire.

The Christmas interruption at the iron and steel works has been slight, and work generally was resumed on Wednesday. In the steel-producing districts of the Swansea Valley there has been marked briskness. Cwmfelin, Duffryn, Forest, Landore, and Pontardawe are very active, both in the bar mills and smelting departments. What the new year will bring is problematical, but the closing year witnesses a greater demand for tin bars than can be supplied.

In tin-plate, beyond some mishaps to the machinery, condition and prospects are regarded as good. Works were generally closed down over Boxing Day. Vessels to load, and now loading in the dock, show the drift of business:—One for New York, others for Batoum, Odessa; one for Mediterranean ports; one for Amsterdam and Rotterdam; one for Baltic ports; and some for France.

During last week the shipment totalled 44,981 boxes, and the receipts from works 49,072 boxes. Present stock is 163,143 boxes. Swansea received last week 3207 tons of pig iron and 950 tons of iron ore.

The spelter refineries in the district are well employed, and a much firmer tone characterises the copper trade as well as the zinc ore trade. I am also pleased to be enabled to record the steady increase of business at the Mannesmann Works. Good orders have been secured of late which promise regular employment. Foundries generally are in full work, especially at Landore and Clydach, and a good deal of overtime up to the holidays was shown at engineering sheds and wagon-repairing yards.

The prosperity in coal may be expected to show itself in the sale of properties. The most important up to the present is the west steam coal Merthyr Colliery at Pontardulais. This is at present idle. Its contiguity to tin-plate and other industries promises a vigorous bidding at the sale next week.

Pitwood is in great demand, and little is sold under 20s. Cargoes came in to Swansea last week from France and Norway, and into Cardiff from France and Spain.

In coke the promise of higher figures is assured. The latest Cardiff quotations have been 26s. to 28s. for furnace, or nearly double the prices of a few months ago, while foundry coke realised from 28s. to 35s., according to brand. Patent fuel remains at 19s. to 21s., and a good demand exists at all ports.

Swansea is exporting coke freely to Australia, and coal shipments to San Francisco are strong.

Good work was done at the South Dock, Swansea, this week. By some mischance an engine ran four trucks to the bridge, which happened to be open, and the four fell into the basin, the couplings fortunately breaking, thus saving the locomotive. In a few minutes a 12-ton steam crane was brought from the Globe dry dock, and a diver, descending, slung the trucks, which were lifted out with the greatest ease.

The Taff Vale Railway Bill for next session is now to hand. It comprises twenty-one clauses. By Clause 4 it is proposed to construct two short junction railways. Railway No. 1 will commence in Radyr parish by a junction with the Penarth Harbour Dock and Railway Company, Penarth branch, and will terminate in Whitchurch by a junction with the railway authorised by the Taff Vale Act of 1897, now in course of construction. Railway No. 2 will commence with a junction in Radyr parish with the company's railway known as Llantrissaint No. 1 branch, and will terminate with a junction at Penarth. Under Clause 13 an extension of time is sought for two years from August 6th, 1900, within which to purchase the lands which were authorised to be acquired by December 10th, Taff Vale Railway Act, 1897.

It is announced at Neath that the old coal firm of Oliver H. Thomas will in future include Mr. D. Thomas the son, and Mr. Snook the chief clerk. The death of Mr. W. Thomas, Brynderwen Colliery proprietor, took place on the 20th inst. He was conspicuous in the promotion of the Neath, Pontardawe, and Brynamman Railway Bill.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

OWING to the holidays and many of the collieries not having resumed work, it is impossible to give any quotation either for steam or house coal. Exports for week ending 23rd were:—Coal, foreign, 74 342 tons; coastwise, 17,500 tons. Imports for week ending 23rd were:—Iron ore, 4550 tons; pig iron, 1950 tons; pitwood, 1667 loads; two cargoes lathwood, one cargo of old rails.

Pig iron: Scotch warrants, 64s. 5d.; hematite warrants, 72s. f.o.b. Cumberland; Middlesbrough No. 3, 64s. prompt. Iron ore: Rubio, 20s. 6d. to 21s.; Tafna, 19s. 6d. to 20s. Steel: Rails—heavy sections—£7 10s. to £7 15s.; light do., £8 10s. to £8 15s. f.o.b.; Bessemer steel tin-plate bars, £7; Siemens steel tin-plate bars, £7 2s. 6d., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 15s. 9d. to 16s.; Siemens—coke finish—16s. to 16s. 3d. Pitwood: scarce. London Exchange Telegram: Copper, £69; Straits tin, £106.

EXPLOSION AT BURTON-ON-TRENT.—The inhabitants of the northern portion of Burton-on-Trent were greatly startled on Wednesday morning by an explosion caused by the combination of coal and sewer gas. The coal gas apparently escaped in large quantities, and accumulated in the old sewers in Waterloo and Princes streets. For the length of a mile all the manholes, numbering twenty, were hurled violently into the air. Several buildings were shaken, and a great quantity of glass was shattered.

CRYSTAL PALACE COMPANY.—The directors of the Crystal Palace Company are promoting a Bill in Parliament next session to divide into £1 shares the whole of their existing £105,000 preference stock, their £95,000 preferred ordinary stock, and their £5000 deferred ordinary stock. The conversion is to take effect on October 1st, 1900. The directors will also seek power to raise £95,000 additional capital by the creation of 95,000 £1 preference shares, ranking equally in all respects with the preference shares which are proposed to be substituted for the existing preference stock.

ITALIAN BATTLESHIPS.—The *Esercito Italiano* states that early next year the work of transforming the Italian battleships Italia and Lepanto will be commenced. The armour belt will be replaced by one of nickel steel; the superstructure will be considerably reduced, making room for a larger number of guns; electrical machinery will be introduced for doing various work on board, including the loading and working of the heavy guns; the number of quick-firing guns will be increased; and the deck protection will be strengthened. The military mast will be retained, chiefly for purposes of signalling.

PORTSMOUTH TRAMWAYS.—The Portsmouth Corporation, who, on the last day of the year, take over from the Provincial Tramways Company all the tram lines in that town, resolved on Wednesday to repudiate the claim of the vendors that they should in addition become purchasers of the omnibuses and carriages belonging to the company. A claim has also been made for compensation for future profits, but the Corporation have been advised that there is no such liability. The company has sent in a demand amounting in all to over £300,000, and, with the consent of both parties, Sir Frederick Bramwell has been appointed arbitrator.

THE DIAMOND TRADE.—According to the *Vossische Zeitung*, the Amsterdam diamond industry is suffering greatly from the effects of the war in South Africa. The number of men out of work there exceeds 2000, of whom at least three-fourths are married. There is no lack of raw diamonds. On the contrary, the stocks would suffice to employ all the workmen in this branch for three months longer. But the trade in diamonds is at a standstill, and there are no buyers for cut stones. The dealers in raw material, therefore, are apparently afraid of a crisis like that of 1890. Should this really occur, at least 50,000 persons at Amsterdam alone will be reduced to the utmost destitution.

RAILWAY ACCIDENTS.—Last Saturday evening three serious accidents occurred in the United Kingdom. During the prevalence of a dense fog, the London, Brighton, and South Coast Company's 5.45 p.m. Pullman Brighton to Victoria train ran into the 5.35 p.m. up boat train Newhaven to London at Wivelsfield. The train from Newhaven, which was bringing up the passengers landed from the steamship La France, which had just arrived from Dieppe, had come to a standstill at Wivelsfield Station, when the up train from Brighton ran into the rear—London Bridge—portion of the boat train. The accident resulted in the deaths of six persons and injuries to a number of others. On the Caledonian Railway four persons were killed and several injured near Glassford, owing to a portion of a train becoming derailed. At Slough, on the Great Western line, on the same date, as the passenger train timed to leave Windsor at 5.40 p.m. steamed into Slough, and was crossing some of the points to draw up at its platform, the Bristol express dashed up by the side of it, striking the engine and the front carriages of the Windsor train obliquely. The Bristol train was timed to stop at Slough, and the signals were against it, but a dense fog which came on suddenly obscured the signals to the driver of the express. The impact derailed both trains and the up line was blocked.

NOTES FROM GERMANY.

(From our own Correspondent.)

MOST branches of the iron trade show signs of increasing strength, the demand being very large and makers all fully sold forward. Consumers of pig iron are still considerably hampered in their transactions by the scarcity of supplies. This week purchases in crude iron have been small, and there was generally a slight quieting down felt, and less was done than in previous weeks, as the works were closing for the holidays.

The production of pig iron in Germany, including Luxemburg, was, for November of present year, 664,388 t., of which 143,348 t. were forge pig and spiegeleisen, 40,979 t. Bessemer, 363,856 t. basic, and 116,205 t. foundry pig. In October of present year, output was 691,266 t.; in November last year, 638,662 t. were produced. During the period from January 1st to November 30th, 1899, 7,384,231 t. pig iron were produced, against 6,740,379 t. for the corresponding period in the year before.

Regarding the tone in the various departments of the manufactured iron industries there was no change perceptible from former weeks, the position being exceptionally healthy all round.

In Silesia bars and drawn wire have met with a very lively demand on foreign account, and last week's local trade in plates and sheets was as brisk as ever. A very satisfactory condition of affairs prevails in the railway and engineering trades, and the tube mills are also in excellent employment. It need not be added that for nearly all articles of iron and steel extreme firmness in quotations is being maintained.

A full and vigorous business continues to be transacted in all sorts of coal and in coke.

A slackening off in the demand for merchant iron continues to be felt on the Austro-Hungarian iron market, while inquiries for railway material have been fairly lively upon the week, and there has also been a regular trade done in plates and sheets; but, on the whole, a want of animation is noticeable, and there is but little spirit of enterprise.

Reports from all the leading iron industries in Belgium show that the strong activity of former weeks is being fully maintained. A very firm tone characterises prices in all departments.

The demand for coal is so very extensive in Belgium that the scarcity in fuel is becoming more disagreeable every week; quotations move up rapidly, and there is really no telling when this rising tendency will cease, as demand promises to remain very good for many months ahead.

A fluctuating tone is reported to have been felt in some branches of the French iron industry, or rather on the Paris iron market, but now again much stiffness was noticeable in quotations, and the number of inquiries that came in last week was large.

Prices for merchant iron are 290f. to 295f. p.t., against 300f. that were quoted a short time ago; girders are being sold at 280f. p.t., and are exceedingly firm. The accounts given of the finished iron and engineering trades are very favourable, all the construction shops being still well supplied with contracts, so that there will be no lack of work for many months to come.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 14th.

THE month of December has been an unexpectedly quiet month in the American steel trade. This quietude is not due to any abundant supply in the hands of consumers, but simply to the growth of a conservative feeling that prices have gone high enough, and that there are contracts out enough for supplies to protect consumers for the next two months. Consumptive requirements are, in fact, increasing, and 1900 will be a phenomenal year in every respect. The very latest inside advices from railroad authorities assure us that there will be a great deal more railroad building undertaken next spring than is now spoken of. There is more railroading projected than at any time for ten years, and nearly all of it is of a character which will be prosecuted because the money is available. There will be quite a railroad building contest throughout the Pacific Coast and Rocky Mountain regions, because of the rapid development of that country. It will extend from British America to Mexico. Twenty or thirty roads of considerable length are to be built, and quite a contest for supremacy will spring up between such railroad magnates as James J. Hill and P. Huntingdon. Competing lines will be built, and there will be a fight for traffic. The entire region is growing remarkably fast because of the mining as well as agricultural developments. Eastern capitalists are finding profitable employment west of the Mississippi River, and hundreds of new manufacturing plants are springing up there to take advantage of the difference in freight rates over shipments from the Far East. The crops are all large, and are selling for good prices. Cotton is worth from 7 to 8 cents, and the planters are rushing it into market. The marketing of the immense crops has produced a very strong feeling in many manufacturing plants and circles. Steel mills are still running full time in all branches and several new plants are to be begun this winter. Two at Pittsburgh, three in Ohio, and one in Eastern Pennsylvania. Capital is taking interest in steel making enterprises such as was never shown before. Congress is in session, and a number of important modifications will be made in the Dingley Tariff Bill. The Currency Bill will strengthen the confidence and remove all uncertainty as to the future financial policy of the Government if there has been any. The Government holdings of gold are said to be increasing.

CATALOGUES.

E. R. and F. Turner, Limited, Ipswich.—Turner-Pegg patent positive valve gear. This is a short illustrated catalogue on Corliss gear, with special reference to the Turner-Pegg gear.

The London Autocar Company, Limited, Gray's Inn-road, London.—Catalogue and price list of motors, component parts, &c.

Wolseley Sheep Shearing Machine Company, Limited, Birmingham.—This is an excellent catalogue of machine tools and appliances. The machines are of the latest design, and embody several improvements.

ALMANACS, DIARIES, &c.

FROM Henry Simon, Limited, of Manchester, we have received a calendar for 1900 of this firm's usual pattern. It is particularly interesting on account of the fact that the mottoes are the collection and choice of the late Henry Simon, the founder of the firm, and on this account the issue will no doubt be particularly appreciated as a memento of his interest in this form of communication with his friends.

The calendar sent us by the White Star Line is of the usual neat type, the monthly cards being designed by Linley Sambourne. The illustrations represent views of the company's latest ship, the Oceanic.

John Rogerson and Co., Limited, Wolsingham, have issued a wall almanac with monthly sheets, on each of which is depicted an excellent view of the works.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

12th December, 1899.

24,685. EXCAVATING APPARATUS, J. T. and W. Titus, London.
24,686. SHAVING LATHER, F. G. Fowler, London.
24,687. FLUSHING WATER-CLOSETS, C. A. Allison.—(*J. Woodbury, United States.*)
24,688. LUGGAGE TRUCK, A. Hollands and M. W. Rich, London.
24,689. PHOTOGRAPHIC FILM HOLDERS, J. R. Gotz, London.
24,690. CIGARETTE and VESTA CASES, J. Needham, London.
24,691. GEAR for TRANSMITTING POWER, E. N. Bray, Glasgow.
24,692. SHARPENING RAZORS, A. V. Kan, London.
24,693. CUTTING OIL GROOVES in STEPS, E. M. Griffiths, London.
24,694. CLUTCH MECHANISM for CYCLES, H. Cresswell, London.
24,695. WALL-TIES, G. M. Callender, London.
24,696. NAIL, G. M. Callender, London.
24,697. KNIFE APPLIANCE, E. W. Breech, Wanstead, Essex.
24,698. INKING APPARATUS, H. E. Newton.—(*R. Hoe, United States.*)
24,699. MAKING METALLIC CASTINGS, W. D. Allen, London.
24,700. METERS, T. B. Wylie, London.
24,701. SUBMARINE ELECTRIC CONDUCTORS, Siemens Brothers and Co., Limited, and W. Dieselhorst, London.
24,702. FIRING MECHANISM, A. T. Dawson and G. T. Buckham, London.
24,703. GEAR for VELOCIPEDES, R. A. Cordner, London.
24,704. APPARATUS for STERILISING MILK, H. Child, London.
24,705. CARPENTERS' MARKING GAUGE, S. Court, London.
24,706. CYCLE SUPPORT, E. E. Bannerman-Dutson, London.
24,707. PUMPS, A. J. Boult.—(*C. M. A. Maginot, France.*)
24,708. OVERSHOES, W. T. Miller, London.
24,709. TIRES, C. T. Adams, London.
24,710. TIRES, C. T. Adams, London.
24,711. GYMNASTIC APPARATUS, E. F. Göransson, London.
24,712. CLOCKS, E. Eppner, London.
24,713. INCANDESCENT GAS BURNER, E. P. Roberts, London.
24,714. BEDSTEADS, S. and S. H. Wilkes, London.
24,715. TERMINAL for PNEUMATIC DESPATCH SYSTEMS, L. K. Gillson, London.
24,716. ORGANS, P. and C. Rossi and L. Spinelli, London.
24,717. FIRE ALARM, B. J. B. Mills.—(*The Gamewell Fire Alarm Telegraph Company, United States.*)
24,718. TELEPHONE SYSTEM, J. E. Kingsbury.—(*The Western Electric Company, United States.*)
24,719. MAKING INGOTS, S. A. Cosgrave, London.
24,720. PHOTOGRAPHIC LENSES, T. R. Dallmeyer, London.
24,721. PRODUCING DECORATIONS in RELIEF, F. Pfanzelter, London.
24,722. DYEING FIBRES, M. de Kasperski and L. Morren, London.
24,723. FURNACES for SMELTING ORE, F. E. Hatch, London.
24,724. CYCLE-DRIVING MECHANISM, F. W. Wunderlich, London.
24,725. NURSING NIPPLES, H. J. Haddan.—(*C. W. Meinecke, United States.*)
24,726. REGULATING the SPEED of CINEMATOGRAPH FILMS, E. J. Marey, London.
24,727. MOTOR VEHICLES, S. F. Edge and M. S. Napier, London.
24,728. LENSES for VEHICLE LAMPS, J. H. Pitkin, London.
24,729. OIL CAKE-TRIMMING MACHINES, A. W. French, London.
24,730. SIGNAL APPARATUS for RAILWAYS, A. Hocken, London.
24,731. CHARGING COMPARTMENTS with GAS, T. A. Clayton, London.
24,732. GUIDE for SLIDE-RESTS of LATHES, F. Ruppert, London.
24,733. BLIND-ROLLER ACTION, J. Hughes, London.
24,734. RENDERING OBJECTS INVISIBLE, E. Dodson, London.
24,735. PREVENTING the THEFT of WATCHES, A. Heath, London.
24,736. LASTS, W. P. Thompson.—(*M. Mitchell, United States.*)
24,737. TURNING TOOLS, W. P. Thompson.—(*W. A. Pendry, United States.*)
24,738. BUTTON-BLANK CUTTING MACHINES, W. P. Thompson.—(*W. A. Pendry, United States.*)
24,739. ELECTRIC SWITCHES, W. Ely, Liverpool.
24,740. ELECTRIC SWITCHES, W. Ely, Liverpool.
24,741. CENTRIFUGAL TESTING MACHINES, M. Eggeman, Liverpool.
24,742. REGULATING WATER TURBINES, F. Ruoss, Liverpool.
24,743. DESTROYING or REMOVING OLD PAINT, T. Huson, Liverpool.
24,744. HOLDING PHOTOGRAPHS in the DEVELOPING BATH, T. E. C. Wilson, Liverpool.
24,745. BREAST or SHOULDER PADS, K. Kratzer, Liverpool.
24,746. COLLAPSIBLE TABLES, &c., F. Mack, Liverpool.
24,747. RAILWAY COUPLINGS, E. H. Q. Henriques and J. H. Wood, Manchester.
24,748. SULPHURIC ANHYDRIDE, G. W. Johnson.—(*Verein Chemischer Fabriken in Mannheim and A. Clemm, Germany.*)
24,749. SCALES for WEIGHING, O. Vitcoq, London.
24,750. POCKET RECEPTACLE for SALIVA, E. Edwards.—(*C. Hülsmann, Germany.*)
24,751. APPLIANCES for CASTING STEEL, R. A. Hadfield, London.
24,752. SHOULDER BRACES and STOCKING SUSPENDERS, E. Rouse, London.
24,753. SASH FASTENERS, A. Forin, London.
24,754. SEWING MACHINES, E. G. O'Donnell, London.
24,755. AIRING APPLIANCES for STOVES, C. Hindle, London.
24,756. COOLING INTERNAL COMBUSTION ENGINES, L. H. Walter, London.
24,757. UMBRELLAS, A. B. Cameron, London.
24,758. SCREW TAPS, H. O. Nienstaedt, London.
24,759. DIE STOCKS, H. O. Nienstaedt, London.

13th December, 1899.

24,760. ELECTROLYTIC METERS, E. Cross, Aberdeen.
24,761. CYCLE DETACHABLE RIM BRAKES, A. E. Sayer, Birmingham.
24,762. PNEUMATIC UNDER-SADDLES for HORSES, R. Douglas, Glasgow.
24,763. CONSTRUCTION of BICYCLES, H. Johnston, Glasgow.
24,764. TREATING of COMPLEX ORES, F. C. Blythe, Manchester.
24,765. BLACK COLOURING MATTERS, W. H. Claus, A. Rée, and L. Marchlewski, Manchester.
24,766. ANTISEPTIC FABRICS, C. Geiringer, Manchester.
24,767. LADIES' GOLF CAPES, M. Kindler and J. Weinberg, Manchester.
24,768. PROPELLING STEAMBOATS, A. Austin and E. Dry, London.
24,769. FOSTER MOTHERS for POULTRY, J. L. Galway, Halifax.
24,770. STRUCTURAL PARTS of CYCLES, T. Jefferies, Birmingham.
24,771. LUBRICATING SHAFTS of ENGINES, M. Paul, Glasgow.
24,772. VELOCIPEDES, A. G. and E. S. New, Woking, Surrey.
24,773. APPLIANCES for PENCILS, F. K. Macdonald, Glasgow.
24,774. CYCLE BRAKES, The Roulette Cycle Company, Limited, and H. Cook, Coventry.
24,775. SPANNER for DIFFERENT SIZED NUTS, F. B. Smith, Port Talbot, South Wales.
24,776. FAUGH-A-BALLAGH, J. Broderick, Dublin.
24,777. AIR SHIPS and FLYING MACHINES, J. Jones, Dundee.
24,778. CONTINUOUS OILING of MACHINERY in MOTION, A. Burzlaff and F. E. P. Müller, Ruthergien, Lanarkshire.
24,779. GUARD for PLANING and MOULDING MACHINES, R. E. and W. Shepherd, and J. Foden, Manchester.
24,780. GUARD for ELECTRIC TRAMCARS, G. T. Moore, Dublin.
24,781. SHAFT FITTINGS of CARTS, F. H. Parker, Down.
24,782. RIM BRAKES for BICYCLES, W. Long, North Woolwich.
24,783. BRAKE for CYCLES, T. S. James, London.
24,784. RECEPTACLES for EXPECTORATION, W. Davies and H. Garland, West Kirby, County of Chester.
24,785. LAMP for LIGHTING INCANDESCENT BURNERS, W. Kirkcaldy and W. C. Scott, Dundee.
24,786. SPLIT DRUMS, A. C. Vesugar, Manchester.
24,787. RAILWAY COUPLINGS, L. W. Sutcliffe and E. H. Birley, Manchester.
24,788. FLUSHING WATER-CLOSETS, J. E. Kitching, London.
24,789. RAILWAY COUPLINGS, E. Sandford and E. Smith, Birmingham.
24,790. CYCLE BRAKES, E. C. Wright and E. J. Polkinhorne, London.
24,791. ELECTRICAL TRACTION, W. Kingsland, London.
24,792. CONNECTING STRIKERS to MOTOR VEHICLES, W. Kingsland, London.
24,793. UMBRELLAS, C. W., E. A., and F. H. Bluemel, London.
24,794. CLUTCHES, E. C. F. Otto, London.
24,795. COIN-FREED GAME of SKILL, H. J. G. Pessers, London.
24,796. GENERATION of ACETYLENE GAS, A. Westrop, London.
24,797. REFRACTORY FIRE-BRICKS, G. W. de Tunzelmann, London.
24,798. HORSESHOES, J. J. Cressey, London.
24,799. MEASURING ELECTRIC PRESSURE, M. B. Field, Lee, Kent.
24,800. GRAVITY RAILWAYS for RECREATIONAL PURPOSES, A. L. Baird, London.
24,801. PRESERVING FOODSTUFFS, J. J. Möller, London.
24,802. SNOW PLOUGH, H. H. Lake.—(*W. A. McGuire, United States.*)
24,803. FABRIC for PNEUMATIC TIRES, C. K. Welch, London.
24,804. PRODUCING the ILLUSION of RIDING in a RAILWAY CARRIAGE, D. K. Jillson, London.
24,805. REVERSING the CURRENT in CONTINUOUS-CURRENT DYNAMOS, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany.*)
24,806. RAIL JOINT, B. Sürenberg, London.
24,807. TREE for BOOTS and SHOES, B. P. Hardcastle, London.
24,808. ENVELOPE, E. S. Baker, London.
24,809. NEW ALLOY, J. L. Garle and W. Lyle, jun., London.
24,810. PLOUGHS, S. Behringer, London.
24,811. SCHRAPNEL PROJECTILE, G. Roth, London.
24,812. SLATE BLOCKS, E. Reese, London.
24,813. PNEUMATIC DESPATCH TUBE SYSTEMS, The Lanson Pneumatic Tube Company, Limited.—(*W. W. Danley, New South Wales.*)
24,814. BICYCLES, &c., J. H. Barry and J. E. Hall, London.
24,815. SUPERPHOSPHATES for FERTILISING LAND, J. Villars, London.
24,816. SPIRIT COOKING APPARATUS, G. Flohr, London.
24,817. TICKET HOLDER or PROTECTOR, W. J. Edwards, London.
24,818. LEAD SEALS for SECURING LOCKS, Frank Wright's Prepayment Gas Meter Corporation, Limited, and J. D. Forster, London.
24,819. FILTER FUNNELS, J. G. Lorrain.—(*J. M. E. Riedel and O. F. J. Grahl, United States.*)
24,820. PROPELLERS for SHIPS, D. G. Martens, London.
24,821. PROPELLER BLADES, D. G. Martens, London.
24,822. SELF-DRIVING MOTORS, A. Steer, London
24,823. BOTTLE-CLEANSING MACHINES, H. Weskamp, London.
24,824. ELECTRIC INCANDESCENT LAMPS, C. Howard, London.
24,825. MOTIVE POWER GAS ENGINES, P. Denat, London.
24,826. GEAR for ACTUATING CYCLES, M. B. Hern, London.
24,827. BLEACHING of PAPER STUFF, R. J. Yarnold, London.
24,828. SUSPENDING and FIXING LAMPS, E. Lincke, London.
24,829. LOCKS, G. Popesco, Liverpool.
24,830. SMOKE-COMBUSTION DEVICE, H. Schindler, Liverpool.
24,831. HAIRDRESSERS' BLOCK STANDS, C. Frank, Liverpool.
24,832. COMMUTATORS for ELECTRICAL MACHINES, F. Kaeferle, Liverpool.
24,833. DIAPHRAGM for PHONOGRAPHS, C. Grivolas, Liverpool.

14th December, 1899.

24,834. ACETYLENE GAS GENERATOR, L. Stauffert, Baden, Germany.
24,835. MANUFACTURE of CLEANSING COMPOUNDS, J. Templeman, London.
24,836. STEAM BOILERS, J. Haythorn and the Haythorn Tubulous Boiler Syndicate, Limited, Glasgow.
24,837. DISENGAGING GEAR, E. T. Phillips, Cardiff.
24,838. REGULATING the TEMPERATURE of SUPERHEATED STEAM, J. G. A. Kitchen, Manchester.
24,839. LOOMS for WEAVING, R. L. Hattersley and S. Jackson, Keighley.
24,840. COMBINATION of IMPLEMENTS, J. Ford, Derby.
24,841. NEW GAME, H. O. and J. O. Roberts, Gloucester.
24,842. NEW GAME, H. O. and J. O. Roberts, Gloucester.
24,843. CIRCULAR KNITTING MACHINES, W. J. Ford, Leicester.
24,844. APPARATUS for PACKING BISCUITS, G. Herbert, jun., Glasgow.
24,845. FILE for BILLS, J. and H. A. Dividson, Holkham, Norfolk.
24,846. DISTILLING APPARATUS, C. Crepelle-Fontaine, London.
24,847. FACILITATING CONTACT of GASES and LIQUIDS, O. Guttmann, London.
24,848. NAVIGABLE BALLOONS, &c., F. A. Barton, London.
24,849. WAGONS, F. W. Brampton, Birmingham.
24,850. PHOTOGRAPHIC CUTTING SHAPE, M. Helena Lady Saltoun, Fraserburgh, N.B.
24,851. VOTING MACHINES, C. A. Allison.—(*The Trommlitz Vote Register Company, United States.*)
24,852. METALLIC BEDSTEADS, S. I. Whitfield, Birmingham.
24,853. METALLIC BEDSTEADS, S. I. Whitfield, Birmingham.
24,854. METALLIC BEDSTEADS, S. I. Whitfield and G. Gale and Sons, Limited, Birmingham.
24,855. CLEANING the PLUMAGE of POULTRY, A. V. Rushton, Birmingham.
24,856. CLOCK for REGISTERING PURPOSES, J. Newman, J. Newman, jun., and J. Anderson, London.
24,857. OBTAINING VEGETABLE FIBRES, S. Shorter and S. Stanbridge, London.
24,858. FOOD PRODUCT, M. Bernheim and R. D. A. Chaudé, London.
24,859. PUTTING OUT of ACTION HYDRO-CARBON VAPOUR LAMPS, H. J. Smith, London.
24,860. AUTOMATIC LIQUID AMALGAMATOR, The General Automatic Delivery Company, Limited, and C. C. Cooper, London.
24,861. MEANS of TRANSMITTING POWER, M. H. Smith, London.
24,862. SAFETY BALLOON, E. R. Lindseye, Killooney Lodge, Co. Armagh.
24,863. EXPLOSION ENGINES, The Compagnie des Moteurs Duplex, London.
24,864. HOLDERS for SHOES, &c., C. A. Lloyd, London.
24,865. HOT WATER and STEAM BOILERS, W. de Fontaine, London.
24,866. PNEUMATIC ARROWS, H. O. Kratz Boussac, London.
24,867. PREVENTING BREATHING THROUGH the MOUTH, J. Hooper and C. Pope, London.
24,868. DUST-REMOVING DEVICES, M. König, London.
24,869. APPARATUS for DRYING GRAIN, M. König, London.
24,870. BREECH-LOADING FIRE-ARMS, H. W. Gabbett-Fairfax, London.
24,871. BRAKE BLOCK for CYCLE WHEELS, A. Haskins, Birmingham.
24,872. QUOINS for PRINTERS' GALLEYS, G. Assenmacher, London.
24,873. CENTRIFUGAL FANS, S. C. Davidson, London.
24,874. SPRING HOOKS, W. P. Wethered, London.
24,875. GLASS-GRINDING MACHINES, P. Semmer, London.
24,876. MANUFACTURE of MANGANO CALCIUM CARBIDE, W. P. Thompson.—(*P. P. H Macé, France.*)
24,877. MUSICAL INSTRUMENTS, W. P. Thompson.—(*The Fabrik Lochmann'scher Musikwerke Actiengesellschaft, Germany.*)
24,878. LAMPS, W. P. Thompson.—(*E. Gallassi and E. Dossani, Italy.*)
24,879. ELECTRICAL CONDUCTORS, W. H. Isherwood, London.
24,880. ACCUMULATOR PLATE MANUFACTURE, Z. Stanecki, London.
24,881. TESTING STRENGTH of LUNGS, C. O. Paul, London.
24,882. LOOM FRAMES, J. C. Fell.—(*La Société Chaize Prives, France.*)
24,883. WALL PLUGS, R. Haddan.—(*I. Friedinger, Austria.*)
24,884. TAKING PHOTOGRAPHS, F. de P. Romani, London.
24,885. RUGS, H. Hardwick, London.
24,886. DRIVING MECHANISM, J. P. Mathieu, W. H. Lucas, and F. H. Gleim, London.
24,887. LAMPS, T. J. Digby, London.
24,888. HAND BRAKES for ROLLING STOCKS, H. A. Livock, London.
24,889. PROPELLING PLEASURE BOATS, D. Whittle, London.
24,890. TYPESETTING MACHINES, A. J. Boult.—(*F. B. Converse, jun., United States.*)
24,891. SACK or like BRUSHING MACHINES, H. Müller, London.
24,892. BOXES, A. Teppe, London.
24,893. TIMEPIECES, E. Behrens, London.
24,894. TOOL HANDLES, F. A. Heng, London.
24,895. BOTTLES, C. Christiansson, London.
24,896. EXPOSING PICTURES, A. J. Boult.—(*P. A. J. Gasse, France.*)
24,897. DISTRIBUTING LIQUIDS, W. L. Wise.—(*A. Saurer, Switzerland.*)

15th December, 1899.

24,898. ELECTRIC SWITCHES, A. J. Howard, Newport, Mon.
24,899. SPRING-HEEL BOOT, K. Brückmann.—(*H. Glas, Holland.*)
24,900. METHOD for OPENING SHOWCASES, F. T. Johns, Manchester.
24,901. BATHS, M. J. Adams, Leeds.
24,902. WATCH PROTECTOR or HOLDER, J. Fuller, London.
24,903. BOWL for ACETYLENE GAS LAMPS, W. Reynolds, Cork.
24,904. CYCLES, F. Andrew, Kingston-on-Thames.
24,905. PRODUCING PHENOLS from TAR, W. F. Sutherst, Harrogate.
24,906. ANTI-VIBRATOR for LAMP BURNERS, W. Green, Birmingham.
24,907. SPRINGS for RAILWAY PURPOSES, G. Turton, Sheffield.
24,908. FOOT-BOARD TREAD, J. Alcock, Cheadle, Staffordshire.
24,909. BRAKE, W. H. Elliott, Bideford.
24,910. HANDLING STEEL INGOTS, A. E. Muirhead, Glasgow.
24,911. WORK-SETS for MACHINERY, J. Lovick, Birmingham.
24,912. PROPELLERS, J. Holt, Birmingham.
24,913. FLUSHING of WATER-CLOSETS, H. Sutcliffe, Halifax.
24,914. TROLLEY ELECTRIC TRAMWAYS, J. W. Taylor, Manchester.
24,915. TRANSMISSION GEAR, A. Craig and P. L. Renouf, Coventry.
24,916. MOUTHPIECE for USE with TELEPHONIC TRANSMITTERS, A. Eckstein and A. Brooker, Manchester.
24,917. DENTAL FORCEPS with BITS, A. P. Budin, Leicester.
24,918. COMPASSES, A. Waller, Berlin.
24,919. WATER-PRESS CYLINDER, &c., F. Kabatek, London.
24,920. TRYING-UP ACCESSORY for PANEL PLAMING MACHINE, R. J. Skipp, &c., Thornton Heath, Surrey.
24,921. EXPLOSIVE COMPOUNDS, W. H. Akester and H. H. Price, London.
24,922. METAL FENCINGS or RAILINGS, J. H. Round, Birmingham.
24,923. "FOOT-CYCLE," H. Heinrich, Birmingham.
24,924. AWKING MACHINES for DYE-VATS, W. Turner, London.
24,925. SPANNER, J. J. Holmes and A. D. Byrne, London.
24,926. HOT and COLD WATER TAP, F. C. T. Welham, London.
24,927. LETTER-BOXES, A. W. Hitt, London.
24,928. SAMPLE CASE for SHODDY, M. Wertheim, London.
24,929. ADVERTISING APPARATUS, H. B. Hopewell and F. C. Smith, London.
24,930. PENCIL CASES, H. L. Symons, London.
24,931. PENHOLDERS, W. A. P. Werner and C. Junge London.

24,932. CLEANING WOOLLEN FABRICS, J. A. Bolton, London.
24,933. TREATING WOOLLEN FABRICS, J. A. Bolton, London.
24,934. PHOTO-LITHOGRAPHIC PLATES, H. Schmeisler, London.
24,935. COLOUR PRINTING MACHINES, F. R. E. Koehler, London.
24,936. SAFETY BRAKE, W. Wright and J. Moorey, London
24,937. BOOK CASES, I. E. Rockwell and J. D Adams, London.
24,938. COLOURING MATTERS, H. H. Lake.—(*K. Oehler, Germany*)
24,939. CYCLE WHEEL RIMS, A. and E. Pulbrook, London.
24,940. AUTO-MOTOR TROLLEYS, L. Lombard-Gerin, Liverpool
24,941. MASSAGE APPARATUS, W. P. Thompson.—(*F. Daxenberger, Germany.*)
24,942. BRAKES, E. M. Tingley, London.
24,943. RAILWAY VEHICLE APPLIANCE, C. H. Waller, Birmingham.
24,944. ROTARY PRINTING MACHINES, J. S. Morriss, London.
24,945. MECHANICAL STOKERS, &c., W. R. Wood, London.
24,946. DIRT CART, M. Stobbs and J. S. Thompson, London.
24,947. PROJECTING AIR, B. J. B Mills.—(*L. Prat, France*)
24,948. CAILINGS, R. B Ransford.—(*The Basel Mission Tile Works, India.*)
24,949. TILED ROOFS, R. B. Ransford.—(*The Basel Mission Tile Works, India.*)
24,950. ROOFING TILES, R. B. Ransford.—(*The Basel Mission Tile Works, India.*)
24,951. ZINC PLATES, R. B. Ransford.—(*La Société d'Edition Artistique, France.*)
24,952. FIXING CORRUGATED METAL SHEETS, C. Thomas, London.
24,953. PHTHALEIN DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
24,954. BLUE MORDANT DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany*)
24,955. DISPENSING LIQUID MIXTURES, R. W. Vining, London.
24,956. UNIFORMLY LOADED ROTARY PHASE-CURRENT SYSTEMS, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany*)
24,957. DRIVING MECHANISM for MOTOR VEHICLES, C. D. Abel.—(*Aachener Stahlwaaren Fabrik vormals Carl Schwanemeyer, Germany.*)
24,958. ARTIFICIAL DENTURES, G. Poulson, London.
24,959. LONGITUDINALLY RIBBED PIPES, A. Schmitz, London.
24,960. ELECTRODES for ELECTRICAL ACCUMULATORS, C. Lucknow, jun., London.
24,961. GAME, R. H. and J. F. Hemmings, London.
24,962. COFFIN HANDLES, W. Smith, Birmingham.

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24,963. ACETYLENE GASLIGHT, M. and A. J. C. Jackson, Belfast.
24,964. SPEAR for SAMPLING GRAIN, D. F. Alexander, Bristol.
24,965. CLEANER for TOBACCO PIPES, E. G. Easton, Dublin.
24,966. ELECTRIC LOCOMOTIVES, B. Hopkinson, London.
24,967. PREVENTING INCRUSTATION in BOILERS, J. Gottlob, London.
24,968. THERMO-ELECTRIC BATTERIES, B. Jonas, London.
24,969. BRUSHES for BLACKING, &c., A. W. Powell, London.
24,970. ELECTRIC HAIR BRUSHES, C. R. Schmutz, London.
24,971. SPRING MATTRESSES, C. F. F. Meyer, London.
24,972. EXTENSIBLE and ADJUSTABLE HOOK, J. Compradt, London.
24,973. FIRE SPRINKLERS, G. W. Beldam and W. S. Coles, Liverpool.
24,974. WARP KNITTING MACHINES, J. Wilson, Nottingham.
24,975. CASTERS, R. J. Parkes, Liverpool.
24,976. COIN-FREED LOCKS, G. Salter and E. W. Bache, Birmingham.
24,977. FASTENING PNEUMATIC TIRES, A. E. Sayer, Birmingham.
24,978. ELECTRIC LAMP FILAMENTS, W. Morton, Warrington.
24,979. MECHANICAL FISH PONDS, R. Ramsbottom, Manchester.
24,980. AZO COLOURING MATTERS, I. Levinstein and Levinstein, Limited, Manchester.
24,981. AUTOMATIC WEFT for LOOMS, W. H. Baker and F. E. Kip, Wolverhampton.
24,982. AUTOMATIC WEFT for LOOMS, W. H. Baker and F. E. Kip, Wolverhampton.
24,983. AUTOMATIC WEFT for LOOMS, W. H. Baker and F. E. Kip, Wolverhampton.
24,984. STEAM GENERATOR FURNACES, B. F. McTear, Liverpool.
24,985. INKING ROLLERS for PRINTING MACHINES, W. E. J. Webb and S. Thompson, Manchester.
24,986. CHARGING BOTTLES with LIQUIDS, J. Bryden, Glasgow.
24,987. PREPARING STICKS for UMBRELLAS, R. Fortune, Manchester.
24,988. HEALDS for WEAVING LENOS, I. Thompson, Burnley.
24,989. PRESERVATION of MILK for STORAGE PURPOSES, M. M. Hanly, Dublin.
24,990. FURNITURE DRAWERS, J. F. Sloane, Glasgow.
24,991. CHANDELIERS for GAS LIGHTING, C. W. Kemp, Birmingham.
24,992. ASH TRAY and CIGAR HOLDER, A. J. Adams, Birmingham.
24,993. SYPHON FLUSHING CISTERNS, J. West, Sheffield.
24,994. GAMES, A. Hunt, London.
24,995. ADJUSTABLE TOY GUNS, F. W. Cole, Birmingham.
24,996. LADIES' CORSETS, G. Miller, Glasgow.
24,997. TAPS for WATER PIPES, H. H. F. M. Pactow, Liverpool.
24,998. FEEDING BOTTLES for INFANTS, J. C. Blyton, London.
24,999. BALL BEARINGS, H. White.—(*E. Theisen, Germany.*)
25,000. KNIFE CLEANER, G. H. Ellis, Harrow.
25,001. REVERSING ENGINE, C. F. Thompson, Brynyrodin, Llanelly.
25,002. ACCORDIONS, R. Glier, Bonn a/ Rhine, Germany.
25,003. MEANS for PROPELLING CYCLES, &c., F. Lyst, London.
25,004. SEWING MACHINES, W. E. Brock and H. B. Cranage, London.
25,005. WHEELS for CYCLES, J. March, London.
25,006. MANUFACTURE of PLASTIC MATERIALS, F. G. Kleinstauber, London.
25,007. PACKING for PIPE JOINTS, J. A. and S. Fletcher, London
25,008. COUPLINGS for RAILWAY TRUCKS, T. Cloke London.
25,009. PRODUCTION of GAS, A. J. Boult.—(*A. Perrier, France.*)
25,010. PEN and POCKET KNIVES, J. N. Mappin, London.
25,011. ELECTRIC BATTERY, W. P. Thompson.—(*J. P. Fontaine, France.*)
25,012. ELECTRIC ACCUMULATORS, W. P. Thompson.—(*G. Daseking and A. Brandes, Germany.*)
25,013. BALL BEARINGS, R. Hilgenfeld and W. Heinrichsdorff, Liverpool.
25,014. STOPPERS for BOTTLES, W. S. Nettleton, Liverpool
25,015. GAS STOVES and BOILERS, J. Titchett, Manchester.
25,016. COOLING MOTOR CYLINDERS, R. W. Barker.—(*P. Bourdiaux, France.*)
25,017. HOSIERY MACHINERY, H. Clarke, London.
25,018. BALL-BEARINGS, C. D. Abel.—(*E. Theisen, Germany.*)
25,019 SAFETY FUSES, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany*)
25,020. BOTTLE-CLOSING DEVICES, A. V. Delerie and J. H. Ridder, London.
25,021. LAMP BRACKETS for CYCLES, A. Bucknall, London.
25,022. MANUFACTURE of CRACKERS, H. N. Cahen, London.
25,023. CARD-INDEX LOCKING DEVICES, C. McPike, London.
25,024. SWINGING CONVEYORS, C. E. Kreiss, London.
25,025. FILE CUTTING APPARATUS, H. Donath, Edinburg.
25,026. FEEDING MATERIAL to BRICK-MAKING PRESSES, H. Alexander, London.
25,027. BRICK-MAKING MACHINES, H. Alexander, London.
25,028. METAL STRUCTURES, S. E. Page.—(*The International Metal Lath Company, United States.*)

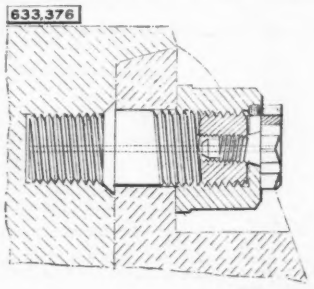
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

633,376. MEANS FOR SECURING PROPELLER BLADES, *L. Davies, Liverpool, England.—Filed May 22nd, 1899.*

Claim.—Means for securing the blades of a propeller to the boss, comprising studs or bolts 2 screwed into

633,376

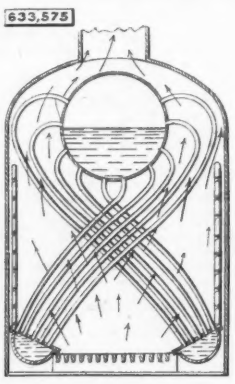


the boss and each formed with a passage 8, a series of holes 11, and a screw-threaded hole 6, a reversely screw-threaded cap-nut 4 formed with an aperture 5, a set-screw 7 formed with a passage 9 and a series of recesses 10, and a pin or screw 12, as set forth.

633,575. WATER-TUBE BOILER, *E. C. de Varmett and E. M. Haynes, Hampton, Va.—Filed July 17th, 1899.*

Claim.—In a water-tube boiler, the combination with water drums and a steam drum, of a plurality of series of water tubes communicating with said water drums and with opposite sides of the steam drum, and crossing each other over the fire-grate to form a

633,575

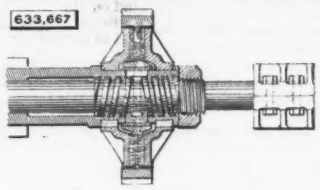


bridge, the shorter tubes of each series being arranged farthest from the more intense heat zone of the fire, and leading from the lower portion of the steam drum, and the other tubes communicating with the upper portion of the steam drum, substantially as described.

633,667. CLUTCH FOR HOISTING MACHINES, *C. L. Taylor, Alliance, Ohio.—Filed June 19th, 1899.*

Claim.—(1) In a clutch, the combination with a shaft having right and left-hand threads, and threaded sleeves mounted on said shaft, each sleeve carrying a friction ring, of a clutch section interposed between the friction rings, and a pinion secured to one of said sleeves. (2) In a clutch, the combination with a shaft having right and left-hand threads, female threaded

633,667

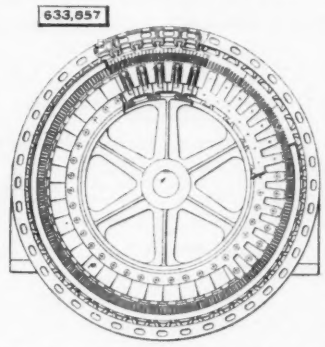


sleeves mounted on said shaft, and having interlocking teeth in their adjacent ends, a pinion on one of said sleeves, and an adjusting nut secured on the shaft and forming an end bearing for one of said sleeves, of a clutch section interposed between the friction rings, and means for holding the clutch section against movement in one direction.

633,857. DYNAMO-ELECTRIC GENERATOR, *B. G. Lamme, Pittsburgh, Pa.—Filed April 14th, 1899.*

Claim.—(1) In a dynamo-electric generator, a rotary laminated field-magnet core having radial pole pieces provided with coils and with side grooves adjacent to the outer ends of the coils, metal coil-retaining wedges or plates held in position by projections located in said grooves, and projecting over the edges or tips of the pole pieces. (2) In a dynamo-electric generator, a field-magnet core comprising a plurality

633,857

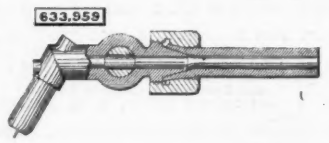


of annular laminated segments separated by ventilating spaces, the outer ends of the pole pieces of said core being joined by metal coil-retaining wedges that extend over the edges or tips of the pole pieces. (3) In a dynamo-electric machine, the combination with a stationary frame having a laminated core separated by spacing-plates into a plurality of annular segments, of a spider provided with a laminated core separated by spacing-plates into a plurality of annular segments, the pole pieces of said core having side grooves near their outer ends, and wedges co-operating with said grooves to retain the field-magnet coils in position.

633,959. DEVICE FOR CONNECTING HOUSE SERVICE PIPES WITH WATER MAINS, *H. Hawkes, New York, N.Y.—Filed April 15th, 1899.*

Claim.—A tap for water mains, consisting of a metal piece having at one end a downward projection for connection with the main, a valve in said piece, the other end of said piece having a screw-threaded por-

633,959

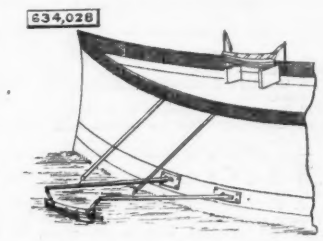


tion, a conical projection beyond said screw-threaded portion, and a nut having a portion of its interior formed cone-shaped to correspond with the conical projection, whereby the soft-metal house pipe may be connected directly to said tap without the necessity for wiped or packed joints, substantially as described.

634,028. MEANS FOR LAUNCHING LIFEBOATS FROM VESSELS, *J. Pollitz and E. H. Cox, New York, N.Y.—Filed October 27th, 1898.*

Claim.—A lifeboat launching apparatus, comprising two davits, pivotally secured to the side of a vessel, the connection being such as to cause one of them to

634,028

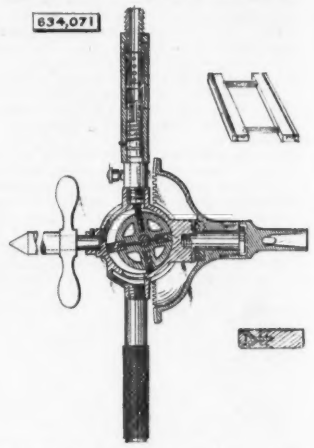


swing outwardly at a different angle to the side of the vessel from that of the other, in combination with means for connecting a lifeboat to the free ends of said davits, and for manipulating the same while being lowered, substantially as set forth.

634,071. PNEUMATIC HAND DRILL, *C. T. Smith, Cleveland, Ohio.—Filed March 16th, 1899.*

Claim.—(1) In a power drill, the drill body and the handles thereon, and a tube in the inlet handle having a valved passage for the motive fluid, and a valve connected with said handle to open and close said passage, said handle being threaded on said tube and adjustable, substantially as described. (2) A power drill and its handles, one of said handles comprising a fixed tube with a valve seat at its outer end, and

634,071

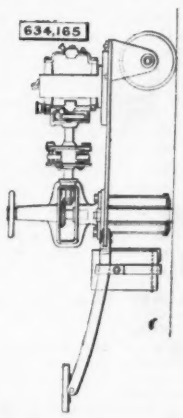


the handle proper threaded on said tube, and a valve connected therewith in position to seat on the end of said tube, substantially as described. (3) In power drills, the body and the handles thereon, a tube fixed to said body, and having the inlet handle adjustably sleeved thereon, and a valve seat at its outer end, a valve fixed in said inlet handle to seat on said tube, and a nozzle in the extremity of said handle, substantially as described.

634,165. PORTABLE ELECTRIC DRILLING MACHINE, *A. L. Croncau, Paris, France.—Filed June 23rd, 1899.*

Claim.—Apparatus for drilling metal sheets or plates, in particular flat metal sheets, with magnetic adhesion device for keeping the surface to be drilled against the drilling tool, consisting of the combination with a metal platform suitably supported by a single wheel and two electromagnets constituting the feet of the machine, and serving to produce the requisite adhesion of the machine to the surface to be drilled, a bracket

634,165



carrying the drilling tool fixed on the platform immediately over the electromagnets so that the drill operates between these, an electrometer fixed on the rear part of the platform connected to the driving shaft of the drilling tool by an elastic coupling resistance and a commutator included in the supply circuit of the motor and electromagnets, carried on the front part of the platform and handles on the platform carrying a seat for the operator so that he faces the machine in a convenient position for controlling its action, substantially as herein described.

LAUNCHES AND TRIAL TRIPS.

PETER HAMRE, steel screw cargo steamer; built by, the Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of, Mr. P. Hamre, of Bergen; dimensions, 245ft., 32ft., 16ft. 1in.; engines, triple-expansion, 16in., 25½in., 42in., by 30in. stroke, pressure 175 lb.; constructed by, the builders; launch, December 21st.

LOCKWOOD, steel screw steamer; built by, Craig, Taylor, and Co.; to the order of, Constantine Pickering and Company; dimensions, 299ft. by 43ft. by 21ft. 3in.; engines, triple-expansion, 21in., 35in., 57in. by 39in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; launch, December 21st.

END OF VOL. LXXXVIII.